ON

DEFORMITIES

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THE

SURGERY OF DEFORMITIES

BY

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TO

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FORMERLY MEMBER OF THE COUNCIL, AND OF THE COURT OF EXAMINERS OF
THE ROYAL COLLEGE OF SURGEONS OF ENGLAND

THIS WORK IS
RESPECTFULLY AND AFFECTIONATELY
DEDICATED
BY HIS OBLIGED FRIEND

THE AUTHOR

PREFACE.

In the preparation of this manual my intention has been to produce a practical and useful guide to the diagnosis and treatment of Deformities of the Human Body. I have, therefore, confined myself as much as possible to the discussion of those methods of treatment from which I have witnessed the best results, both in my own practice and in that of other surgeons. I have not neglected to acquaint myself with the various standard works and monographs which treat, either incidentally or specially, of Orthopædic Surgery; thus I have collected together most of the more important improvements in practice and additions to our knowledge which have been published abroad or in this country.

E. Noble Smith.

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CONTENTS.

CHAPTER IX.

CHAPTER X.

CHAPTER XI.

CHAPTER XII.

CHAPTER XIII.

THE

SURGERY OF DEFORMITIES.

CHAPTER I.

THE NATURE OF DEFORMITIES.

THE deformities which will be dealt with in this volume have been commonly classed under the term Orthopædic;[1] but the writer has adopted a title which he thinks is more comprehensive in its meaning.

Perhaps the most practical definition of the class of deformities which belongs to this department of surgery is that given by Mr. Chance,[2] whose excellent and original work upon the subject will be referred to again in several parts of this volume.

The word 'deformity' is defined by Mr. Chance as follows: 'an original or an acquired deviation in the skeleton from the standard of its ordinary healthy development,' 'its component parts being either altered in number, in structure, in shape, in relative position, or in the freedom of their move-

[1] The word Orthopædic was invented by Andry, who formed it from the Greek ὀρθός = straight, and παῖς = a child, in his work entitled *L'Orthopédie, ou l'Art de prévenir et de corriger dans les Enfans les Difformités du Corps, le tout par des moyens à la portée des pères et des mères et des personnes qui ont des enfans à élever.* Par M. Andry, Conseiller du Roy, &c. Paris, 1741.

[2] *Bodily Deformities*, by E. J. Chance, F.R.C.S., &c., part i., 1862.

ments over each other, so as to modify and disfigure the external form of the body, or to interfere with the proper exercise of the functions of the part, or with those of the part adjacent.' So that a deformity, 'in a surgical sense, essentially consists in an imperfection of form or of motion, frequently of both combined, arising from an alteration in, or an undue action upon, the skeleton.'

It will be found in the sequel that this definition is almost entirely adhered to.

In the following table deformities are arranged upon a plan which is a slight modification of one published by Mr. Chance.

DEFORMITIES OF THE HUMAN BODY.

1. Originating before birth—congenital.
2. Originating after birth—acquired.

- I. Congenital deformities may originate in
  - 1. The germ . . . . .
    - 1. Error in the germ (male or female);
    - 2. Error in primary impulse (E. J. Chance).
  - 2. The embryo or fœtus (deformation of the originally normal germ).
    - Excess of development.
    - Arrest of development.
    - Mechanical injury.
    - Disease, as below.
- II. Acquired deformities may originate in
  - Acting directly on the skeleton.
    - Disease . . . .
      - Rachitis.
      - Osteomalacia.
      - Other bone diseases.
      - Joint affections.
      - Rheumatism.
  - Acting indirectly on the skeleton.
    - 1. Disease or error in the exciting cause of muscular action.
      - 1. Excess or spasm.
      - 2. Deficiency or paralysis.
    - 2. Disease or error in the muscle itself.
    - 3. Mechanical impediments
      - Contraction of skin, fasciæ, and ligaments.
    - 4. Deficient support . . .
      - Relaxation of fasciæ and ligaments.

Congenital Deformities.

1. *Fault in the Germ.*

The germ may be originally malformed, which must be the case when the same kind of malformation repeatedly occurs in the offspring of the same parents. The error may occur in the ovum or in the spermatozoa.[1]

[1] Mr. Chance suggests the possibility of the fault occurring in the primary impulse of development.

In support of the assertion that malformations in the human body may arise from faults originating in the germ may be adduced the fact that deformities often occur in oviparous animals;[1] but perhaps the most conclusive proof is afforded by the hereditary nature of those deformities which consist in excess of development.[2]

2. *Excess of Development.*

Excess exists as duplicity, more or less perfect. The Siamese twins are an instance of *lateral duplicity*. A monstrosity with two heads, or with two lower extremities blended into one body, is an example of partial duplicity; and supernumerary limbs, or fingers and toes, are instances of a slighter grade of excess.

It was formerly supposed that the cause of such deformities, especially in the case of double monsters, was the fusion of two ova or two embryos; but such hypothesis has been opposed, and it has been asserted that they are due to an attempt at multiplication by gemmation or fission, arising at a period of development when the condition of the ovum corresponds to that of a hydra.

The instances of a fœtus being found in the body of a male child, however, would seem to accord rather with the former than with the latter theory.

3. *Deformation of the originally Normal Germ.*

Maternal Impressions.—The belief that a maternal impression can produce deformity *in accordance with the idea of the mother* has a very ancient origin, and is entertained by many medical men at the present time. It therefore becomes necessary to state the following facts which are in opposition to such belief:—

[1] See specimens in the Museum of the Royal College of Surgeons.

[2] See Dr. Joseph Adams, *Treatise on the Supposed Hereditary Properties of Disease*, &c., 1814; also Professor Hutchinson's *Lectures at the Royal College of Surgeons*, 1881; also E. J. Chance, *op. cit.*

1. That the resemblance of the deformity to the object which has impressed the mother is generally an imaginary one.

2. That the maternal impression is almost invariably only alluded to *after* the discovery of the deformity.

3. That the ovum, as soon as it leaves the ovary, ceases to be connected, either by the nervous or vascular systems, with the mother, and, therefore, in resembling very closely the egg of an oviparous animal, becomes almost equally unlikely to be influenced in the manner referred to.

4. That from the nature of the deformity we may usually know that the error in formation must have occurred at a much earlier period than the date of the supposed cause, and this is especially the case when the error is one of excess.

5. That, in the words of Dr. Blundell, 'it is contrary to experience, reason, and anatomy to believe that the strong attention of the mother's mind to a determinate object or event' can cause 'a specific impression upon the body of the child without any injury from without.'

A great shock to the mother, even if only a mental one, may affect the general condition of the fœtus, may retard its development, or may even cause its death; but that the mother's mind being affected by the sight of a deformed or injured hand, lip, or other part of the body can produce a malformation of a *corresponding part of the body* of her child *in utero* is a supposition which physiological facts will not allow us to entertain.

If it be thought necessary to pursue this subject further, the only manner in which reliable evidence can be obtained is as follows:—The observer must question each mother *before delivery* as to any impressions she may have formed upon the subject, and compare these with the actual condition of the child when born. It is probable that nearly every pregnant woman entertains doubts and fears with regard to the condition of her coming offspring, and that when her child is born in a normal condition her apprehensions are soon forgotten; but that when an abnormality exists, the fear is magnified into an important fact.

In past ages congenital deformities were attributed to various causes, amongst which may be mentioned Divine vengeance, witchcraft, and intercourse with animals, &c.; but the knowledge which we now possess of the various phenomena of embryonic development enables us to determine that many deformities depend either upon *arrest* or *excess* of the processes of formation.

4. *Arrest of Development.*

Class 1. Cleft sternum.
2. Deficiency of anterior walls of thorax and abdomen.
3. Displacement of viscera.
4. Fissure of pubic and hypogastric regions.
5. Cervical fissure.
6. Fissures of the face.
7. Cyclopia.
8. Monotia (deficiency of lower jaw).
9. Fissure of the vertebral column.
10. Other defective development of spinal column.
11. Deficiency of head (*acrania*).
12. Deficiency of parts of trunk and extremities.
13. Defective formation of extremities.

The majority of these deformities do not come within the domain of orthopædic surgery, but the results of arrest of development of the spine and the extremities have to be dealt with.

In the development of the *vertebral column* the matrix of the bodies of the vertebræ is first formed, and subsequently the cartilaginous arches are developed. The arches proceed from before backwards, and are formed first in the dorsal region.

The development of the arches proceeds upwards towards the cranium, and downwards to the sacrum, and is deficient in the lower sacral and coccygeal vertebræ.

Incompleteness of this normal development produces fissure of the column (*spina bifida*).

Fissure of the spinal column in its highest grade involves the bodies of the vertebræ; but such degree of deformity is very rare, and deficiency of more or less of the arches is the more common condition.

The arches may be quite absent, or the two arcs may be complete, but ununited, so that a space exists in place of the spinous processes, the latter being separated into two lateral and equally incurved parts.[1]

Sometimes the fissure exists along the whole of the column, but much more frequently the deformity is confined to one or two vertebræ.

The lumbo-sacral region is most usually affected, next in frequency the cervical region, and lastly the dorsal. This arrangement is in accordance with the progress of development.

The vertebræ may be otherwise deformed, giving rise to shortness of the column from deficiency of one or more vertebræ; or portions of vertebræ may be absent, causing curvature of the spine. Vertebræ may be fused together.

Defective Formation of the Extremities.

There may be—

1. A want of all the extremities.
2. 'Want of the intermediate parts in the extremities, so that the hand is attached immediately to the shoulder and the foot to the hip.'
3. Limbs too short.
4. Limbs truncated.
5. Diminished number or parts of fingers and toes.
6. Coalesced fingers and toes.

Thus deformity, and even monstrosity, may occur in consequence of an arrest of development of one portion of the body, while nutrition and growth proceed normally in the others; and the majority of these conditions, although unnatural at the time of birth, are perfectly natural to certain stages of embryonic formation.

[1] Vrolic, in *Cyclopædia of Anat. and Phys.*

5. *Mechanical Injury and Disease.*

These two causes of deformity are classed together, because the origin of congenital club-foot and similar distortions has been attributed by various writers sometimes to the one and sometimes to the other cause (as well as to malformation).

Dr. Little has furnished us with a history of the opinions upon which the following remarks are chiefly based.

History of various Opinions upon the Cause of Congenital Club-foot.

Duverney[1] and Boyer[2] both believed in unequal muscular action, and the latter considered position *in utero* to be an exciting cause.

Scarpa[3] thought that the primary cause was malposition of the bones.

Jörq believed that abnormal muscular action gave rise to this deformity.

Rudolphi,[4] in a more scientific work, advocated the theory of disordered nervous action.

Delpech[5] at first thought that club-foot was caused by malformation of the tarsal bones, but he subsequently[6] renounced this opinion and adopted the theory that the deformity depended upon abnormal muscular action.

Cruveilhier[7] believed that club-foot and club-hand occur as a consequence of 'the limbs of the fœtus being arranged in improper positions in relation to each other and to the trunk of the body, by which their mutual development is impeded.'[8]

Tortual entertained views somewhat similar to Cruveilhier.

[1] *Traité des Maladies des Os.*

[2] *Leçons du Citoyen Boyer*, rédigées par A. Richerand. Paris, 1803.

[3] *Memoria chirurgica sugli Piedi Torti congeniti*, &c., 2nd edit., Pavia, 1806.

[4] *Physiologie.*

[5] *Chirurgie clinique de Montpellier.* Paris et Montpellier, 1823.

[6] *De l'Orthomorphie.* Paris, 1829.

[7] *Anatomie pathologique du Corps humain.* Paris, 1830.

[8] Little, *Deformities.* London, 1853.

Von Walther[1] thought that Talipes varus was a grade of the natural process of development of the feet. (But even if such was the case it would not explain the occurrence of *T. equinus* and *T. valgus*.)

Jules Guérin[2] strongly advocated the theory of deranged nervous system as a cause of congenital club-foot.

The foregoing are those referred to by Dr. Little.

Eschricht is referred to by Billroth[3] as having 'shown that at the commencement of their development the lower extremities lie with their backs against the abdomen, the hollows of the knees being against the belly; so during the earlier months the legs must rotate on their axes, and the toes, which pointed backwards, must point in the opposite direction. If the embryonic extremities lie so close as to appear united under a common skin, or be really united, the above-mentioned rotation of limbs cannot occur, and in this deformity (siren) the feet are turned directly backward. This rotation on the axis, which was arrested in the above case, does not take place fully in club-foot; the rotation in the foot is not fully accomplished. According to this, congenital club-foot would come among cases of obstructed development; about its cause we know as little as we do of other deformities of the same class. The abnormal forms observed by Hueter, especially the obliqueness of the ankle bones, unsuitable length of the muscles, among which shortness of the gastrocnemius is the most conspicuous and longest known, must be regarded as consequences of this faulty direction of the foot *in utero*, which is subsequently increased.'

Position in utero has been considered by many writers to be the most probable origin of these distortions, but there are many reasons for discountenancing this opinion, and Mr. Chance brings forward the following strong arguments against such a theory :—

[1] *System der Chirurgie*. Berlin, 1833.

[2] *Mémoires sur les Difformités.*

[3] *Pathology and Therapeutics*, translated by C. H. Hackley. London, 1874.

It is certain that long after the formation of the limbs the embryo is well protected from pressure from the uterine walls by the liquor amnii which surrounds it.

That at the fourth month the quantity of liquor amnii is about 2½ ounces, or half the bulk of the embryo.

That it is only during the last two or three months that the movements of the fœtus are impeded by its constrained position, and that then the usual quantity of liquor amnii is sufficient to prevent unequal pressure upon any one portion of the child.

That in cases where the liquor amnii is deficient, if it 'did not exist in sufficient quantity to constitute a positive layer, no matter how thin, between the walls of the uterus and the fœtus, to equalise the pressure which at this time is exerted upon it, the child could never be born alive,' in consequence of interference with the circulation.

That 'during the later months of gestation the fœtus is curled upon itself,' with the arms across the chest; 'consequently, if the simple fact of impeded motion in a member originally accurately developed, and each of its parts endowed with its proper functions, could give rise to deformity, by enabling one set of muscles to obtain the ascendency in power over their natural antagonists, or to cause unequal development between them, we ought as the rule to have every child born with contraction of the neck, the thighs, and the legs; causing the head to be bent forwards upon the chest, the thighs to be drawn close up to the abdomen, and the legs to be partly flexed upon the thighs.'

That in the many reported cases of deficient liquor amnii that Mr. Chance is acquainted with no instance of distortion has been given, whereas cases are reported of deformities accompanying excessive quantity of liquor amnii—one by Dr. Greenhalgh at the Westminster Medical Society, in 1844–45.

At the present day the prevalent opinion is that congenital club-foot is dependent upon some disturbance of the nervous system, which causes muscular spasm in the fœtus, such disturbance lasting sufficiently long to set up a shortened state of the muscles, which becomes permanent.

In considering the subject of nerve disturbance in the fœtus, we are naturally led to enquire into the conditions which may give rise to such disturbance.

Various febrile affections are known to attack the fœtus. We may instance small-pox and scarlet fever, and a child has been known to be born marked with the small-pox, although the mother had escaped infection. Fevers sometimes produce affections of the nervous system in children, and therefore might do so to the fœtus.

Diseases of the nervous system are known to be hereditary, and as very young infants may develope these diseases, it is to be presumed that the fœtus *in utero* may also be attacked by them.

The hereditary nature of convulsive diseases is sometimes exemplified in the death of successive children, either soon after birth or during intra-uterine life.

Mr. Curgenven had a patient [1] with whom in four succeeding pregnancies the fœtuses died about the eighth month, and the sensations of the mother immediately preceding the period of their deaths indicated the occurrence of convulsions. Of this lady's family nine out of ten brothers and sisters had suffered from convulsions during infancy, and six had died from the attacks. Convulsions have been known to occur in a child before birth, and the child when born was affected with general muscular contractions: convulsions occurred at the time of birth, and continued until death, which took place a few days after birth.[2] Spasmodic pains had been felt by the mother for six weeks previous to birth.

Mr. Chance, in his remarks upon this subject, refers to the fact that spasmodic convulsive disease and paralysis may affect

[1] See *British and Foreign Med.-Chir. Rev.*, article by Dr. Sedgwick, Oct. 1867.

[2] See case in *Edin. Med. Journal*, Nov. 1862, by Dr. M'Leod, of Kilmarnock.

the fœtus *in utero* at an early or late period of intra-uterine life, and give rise to deformity of greater or less severity accordingly. Whatever the origin of this spasm, the spasm itself may be either tonic or transitory, ' or of a more protracted or even of a permanent character; and it may be of greater or less severity,' and may terminate in :

1. Perfect subsidence;
2. Partial subsidence; or
3. Paralysis.

These different terminations explain the different conditions in which we find the muscles in various cases. If spasm lasts only for a few days a considerable amount of mischief will be produced, for the ' development of the fœtus progresses with great rapidity; and although the actual increase in bulk and length of the entire fœtus may appear minute, that amount of increase . . . . is nevertheless immeasurably greater *in proportion to the entire bulk of the fœtus* than can occur at any future like period. Consequently if this spasmodic condition of a muscle or set of muscles be maintained . . . . each of the contracted and extended muscles of that member would be thus permanently fixed in a relatively disproportionate length . . . . by the new-formed muscle having been added, in the one case to a muscle in the condition of firm spasmodic contraction . . . . and in the other to a muscle in a state of full, normal, and passive extension.' In the latter case the muscle is congenitally elongated; in the former it is congenitally shortened. ' In both instances the muscles are much less in size and in power than those of the opposite limb,' and yet in both they may be able to contract under volition.

' If the cause of the spasm' is more permanent, and the spasm itself severe and prolonged at an early stage of development, paralysis will ensue, and not only will the muscles be irregular in length, but also structurally disorganised, and probably the bones will grow irregularly.

Spasm may occur late in uterine life; perhaps at the moment of birth, or the moment after birth. Therefore we can hardly draw a distinction between congenital and non-congenital spasm.[1] The association of club-foot and other deformities, the result of perverted muscular contractions, such as club-hand and contractions of the legs, arms, &c., with the cases of monstrosity, involving the cerebro-spinal system, is strong evidence in favour of the presumption that these congenital deformities arise from nerve irritation.[2]

Dr. Little, in support of this theory, states that non-congenital club-foot occurring early in life presents 'the same inflexible and essential characters as the congenital affection; that it advances nearly to the same grade of deformity, and is remediable by the same means,' and therefore it is probable that the congenital arises from similar causes to those originating the non-congenital. Dr. Little[3] further states that it has been asserted that there is no tendency to relapse after relief of congenital deformity, but every surgeon who has treated even a few cases of congenital club-foot knows 'that after complete flexibility of the ankle has been obtained, the neglect of certain manipulations and exercises is often followed by return of considerable contraction. Now it is obvious that if the dynamic property of the muscles of a joint be intact, and entire flexibility be obtained, either with or without operation, no tendency to relapse should exist; for if the muscles originally contracted be right in their functional activity, ordinary exercise would, as in the case of a sound limb, maintain the flexibility.' But in congenital club-foot there is sometimes a tendency to relapse, and 'perfect development of the muscles does not ensue.'

'In many cases, especially the congenital, and in many non-congenital cases, the tonic or dynamic cause of distortion has subsided, the deformity being only maintained by structural shortening.'

[1] 'In a case under my own care,' writes Mr. Chance, 'violent fits occurred the day after birth in an infant born with Talipes equinus. In this case it is possible the fit was the result of causes that had been active previously to birth and had originated the deformity.'

[2] See Guérin, *Mémoires sur les Difformités.*

[3] *Deformities*, Lond. 1853.

On the other hand, dissections have been made which show that deformities of the bones *do* sometimes exist; but these must be considered exceptions, and must be held as quite distinct cases from ordinary club-foot, the latter being doubtless the effect of abnormal muscular contractions (see p. 17, 'Abnormal Muscular Contractions').

Injuries supposed to be caused by the Umbilical Cord.

The umbilical cord gradually increases in length and thickness during gestation until at the time of birth it is about half an inch in diameter and about eighteen inches in length. It has been said, however, to vary in length between two inches and five feet. A cord of the *natural* length may become coiled round the neck or limbs of the fœtus, but if it is unusually long such an accident is naturally more likely to occur. The child has thus been killed by compression of the cord; but at other times the coiling has been so loose that no harm has resulted. Such unnatural position of the cord may be produced by excessive movements upon the part of the mother during pregnancy, especially when there is excessive length of cord. The evils resulting may vary. There may be a mere indentation of the compressed part, or a deep groove may be formed, or the limb may be curved or its development arrested.[1]

The pressure of the cord under these circumstances has been supposed to cause amputation of a limb; but it is probable that the amount of compression that would be necessary to bring about such a result would first arrest the circulation of the funis, and so cause the death of the fœtus.

Spontaneous amputation may, however, occur, and Richerand, Desormeau, Billard, and Murat have written upon such cases, although they do not seem to have witnessed any. Watkinson records a case where the amputated foot was found *in utero*. Chaussier refers to three cases. In two, a part of the forearm was partially separated, and in one the arm had been amputated

[1] See E. J. Chance, *op. cit.*

and was found by itself, and the stump had healed. Montgomery gives ample evidence of these accidents, and shows that thread-like bands, the results probably of inflammation, are the cause of the amputations from encircling the limb.[1]

Fracture of the bones occurs sometimes *in utero*, and the history may or may not record a fall to the mother (Dugès, Marc, Chaussier, &c.)

It is probable that the bones are preternaturally brittle in these cases (113 fractures have been recorded in one case !)

Dislocations may occur, under which circumstances probably the ligaments will be found abnormally lax.

Acquired Deformities.

6. *Rickets.*[2] See Chapter XIII.

7. *Osteomalacia.* See Chapter XIII.

8. *Joint Affections.*

Chronic Inflammation of Joints.—The pathological changes which occur during the progress of the diseases which may be classed under the above designation are a frequent cause of deformity. The disease which from its importance takes a prominent place in this class is *Fungous and Suppurative Arthritis.*

This affection is often termed *scrofulous inflammation of the joints*; but there are many reasons for supposing that the affection is not always a disease of scrofula or tubercle, and these reasons may be summarised as follows :—

1. Cases occur in individuals who are robust, and in whom

[1] *Cyclopædia Anat. and Phys.*

[2] Whether rickets is a congenital or an acquired disease, or sometimes the one and sometimes the other, is still an undecided question ; but it has been found convenient and in accordance with the views of a large proportion of the medical profession to discuss rickets among the acquired deformities.

no *other* symptom or appearance, commonly considered scrofulous or tuberculous, is present.

2. There is nearly always a history of injury to the joint, and those joints are most frequently affected which are most exposed to injury.

3. Perfect rest to the diseased joint, without other treatment, generally (unless the vital powers of the patient are broken down) arrests the disease.

4. This arrest of disease occurs even in patients in whom scrofula or tubercle exists, and even while the *scrofulous* symptoms are increasing.

5. The disease has been arrested, and osseous ankylosis has taken place, although the patient has been reduced almost to death by repeated bleeding.[1]

Upon the other hand, cases are sometimes met with which appear to be the result of tuberculous deposit alone, and it is only by studying the peculiarities of each individual case that a correct opinion can be formed of the true pathological conditions with which each is individually associated.

The opinion that these joint diseases are not necessarily associated with scrofula is entertained by many practical and observant surgeons in the present day.

Mr. Hilton[1] has expressed himself very decidedly upon this subject. His belief that 'the diseases of joints are almost invariably the results of local injury, and that if they were recognised early, and treated by appropriate rest, nearly all of them would get well,' is borne out by the results which have followed treatment when carried out upon that principle.

Mr. Holmes has also for many years urged that chronic joint disease is not a scrofulous affection, although it may occur in scrofulous subjects. As far as the pathology of caries affects this subject, the reader is referred to the chapter upon 'Caries of the Spine.'

In treating these cases the objects the surgeon should have

[1] Hilton, *Lectures on Rest and Pain*, 3rd edit., edited by Jacobson, 1880, lect. xiii.

in view are—firstly and chiefly, to promote resolution; secondly, to prevent impairment of motion in the joint.

The general health of the patient is often little, if at all, affected in the early stage of the disease, but it becomes involved as the local symptoms increase, and especially when suppuration occurs.

When the general health is affected, tonics, good hygienic conditions, &c., are valuable auxiliaries; but absolute rest to the diseased structures is of the first importance, for without it the general treatment will be of little avail.

Any movement which causes pain must be harmful to the joint, but if movement can be made gradually from day to day (without causing pain) adhesion of the inflamed surfaces is interfered with, and ankylosis may thus generally be prevented. The means by which such treatment may be carried out is detailed in the chapter upon 'Hip Joint Disease.'

If the case is being treated in its advanced stages, when no hope of preventing ankylosis can be entertained, then the efforts of the surgeon must be directed to bringing the limb into the position which, with a stiff joint, will be most convenient to the patient, and so retaining it fixed until resolution has taken place.

The subject of excision of the diseased joint is one which is of great surgical interest, and may be considered as still *sub judice*. It will be referred to again in Chapter VIII.

Chronic rheumatic arthritis may cause deformity either by the alteration in relative position of the bones from destruction of the cartilage, or from the deposition of osteophytes in and around the joint surfaces, or from contraction of muscles.

Locomotor Ataxy.—The nature of the peculiar affection of the joint which occasionally accompanies this disease will not be discussed here; but instrumental support to the deformed joints might afford comfort to the patient, if it did not assist the cure.

Abnormal Muscular Contractions.

Compiled for this work by Allen Sturge, M.D., *Physician to the Hospital for Epilepsy and Paralysis.*

[Deformity of any part of the body may arise from an abnormal condition of the muscular system of the part. There are many ways in which deformity may be thus produced. The following is a classification of the principal causes which may be included under this head :—

I. *Causes originating in the Nervous System.*

A. *Conditions inducing active spasm of muscles.*

(1) Congenital.

(2) Acquired.

(*a*) Due to lesions of the brain.

(*b*) „ „ spinal cord.

(*c*) „ „ nerve trunks.

(*d*) Hysterical.

(*e*) Tetanic.

(*f*) Reflex.

(*g*) Unclassed.

B. *Conditions leading to passive contraction of muscles without spasm.*

(1) Congenital—some forms of club-foot.

(2) Acquired.

(*a*) Due to the unbalanced action of groups of muscles where the antagonist groups are paralysed.

(*b*) Due to the maintenance of a paralysed limb in a shortened position for a considerable length of time. When the limb recovers from its paralysis it will retain the shortened position.

II. *Causes originating in the Muscles themselves.*

(1) Disease or injury of the muscles.

(2) Long-continued repose in a shortened position from other conditions than disorder of the nervous system.

I. Causes Originating in the Nervous System.

A. *Conditions inducing Active Spasm of Muscles.*

(1) *Congenital.*

Cases sometimes occur of children who are born with permanent spasm of the muscles of one or more limbs. The causes which may lead to this condition are probably, in the majority of cases, identical with those giving rise to similar conditions after birth, and they may therefore be considered with these.

(2) *Acquired.*

(*a*) *Permanent Spasm resulting from Disease of the Brain.*— The principal form under which this variety of spasm is met with is the secondary rigidity so frequently seen in cases of hemiplegia of some considerable standing. It has now been proved that the secondary rigidity of hemiplegia is immediately due to, or is at any rate intimately associated with, degeneration descending from the seat of the lesion in the brain down those portions of the spinal cord which are known as the pyramidal tracts. The pyramidal tracts are the strands of white fibres in the anterior lateral columns of the spinal cord, which are continuous with the anterior pyramids in the medulla oblongata. The greater part of the fibres forming the anterior pyramids decussate in the medulla, but it was shown by Flechsig that in the great majority of cases the decussation is not complete. The fibres which decussate pass down in the back part of the lateral column of the cord of the opposite side, whilst those which do not decussate pass down in the inner portion of the anterior column in the same side as the medullary pyramid. It has been shown that the fibres composing the anterior pyramid pass upwards through the pores, and through the internal capsule to the cortex of the brain without communicating with the grey matter of the great ganglia at its base. Any lesion of the brain which affects the motor centres of the cortex, or the fibres passing directly from these centres to the spinal cord, is liable to be followed by secondary degeneration in the fibres passing downwards from the seat of lesion; and it is in these cases that the 'late rigidity' of hemiplegia is found. In this condition the arm is held firmly to the side, the shoulder is slightly raised, the elbow flexed nearly to a right angle, the wrist flexed, and the fingers tightly clenched. The leg, on the contrary, is extended, the knee being straight and the toes pointed somewhat towards the ground.

Although it would at first sight seem as though certain groups of muscles alone were involved in the spasm—the flexors in the arm and the extensors in the leg—yet, if passive movement of the limbs be attempted, it will be found that all the muscles partake in the rigidity, although the rigidity of certain groups overbalances that of their antagonistic groups.

When hemiplegia occurs in young children, it is more often due to a cortical lesion than to any other cause. Children have little tendency to rupture of vessels or to the formation of thrombi in vessels, and the hemiplegia which is sometimes met with in infants and young children rarely has the mode of onset usually met with in cases where it is due to these causes. It is, on the contrary, generally preceded by a severe illness referrible to the brain, and in most cases accompanied by convulsions. In cases where it has been possible at a later period of life to make a post-mortem examination, it has generally been proved in these cases that there was general or partial atrophy of the affected side of the brain, with thickening and adhesion of the meninges. A similar condition is frequently found in cases where the hemiplegia has been present from birth. In such cases it is supposed that there has been some inflammatory affection of the brain or its meninges during intra-uterine life. From what has been already said, it is evident that secondary descending degeneration of the pyramidal tracts would be common in these cases; and consequently the hemiplegia of infant and young children is especially liable to be accompanied by rigidity in the affected limbs.

(*b*) *Permanent Spasm arising from Disease of the Spinal Cord.*—The most typical form of spasm due to disease of the spinal cord is the condition to which Erb has given the name 'spastic paraplegia' and which Charcot has described under the term 'tabes dorsalis spasmodique.' In this disease there is paralysis of motion in both legs, associated with extreme rigidity of the limbs, due to permanent muscular spasms. This rigidity is constant, and is not relaxed during sleep, but it is liable to sudden exacerbations, especially at night, when the patient is awakened or prevented from sleeping by strong muscular jerks repeated at frequent intervals. There is no definite rule as regards the ascendency of one group of muscles over another. In some cases the contractions of the flexors overcomes that of the extensors, the legs being maintained in a permanently flexed position; in other cases it is the extensors which are in the ascendant, the legs being held stiffly in a position of extreme extension. In still other cases there is alternation in the position, the legs being sometimes strongly flexed and at others fully extended. It has been shown that this permanent rigidity indicates disease—in most cases fibrous sclerosis—of the lateral columns of the spinal cord, and hence this particular form of paraplegia is getting to be known as 'lateral sclerosis.' Cases are not unfrequently met with in which more or less rigidity of the limbs occurs, although in other respects they do not present the typical picture drawn by Erb and Charcot. In these cases the lateral columns of the cord are probably more or less involved in common with some other parts of the spinal cord. Thus stiffness of the legs is a frequent concomitant of the paraplegia resulting from Pott's disease of the spinal column. Charcot has described a peculiar form of disease in which stiffness is associated with muscular atrophy, to which he has given the name 'atrophic lateral sclerosis.' He believes that in these cases there is sclerosis of the lateral columns of the cord, with subsequent implication of the large cells of the anterior horns of grey matter which control the nutrition of the muscles. The lateral sclerosis causes weakness and stiffness of the muscles, and the extension of the lesion to the anterior horns causes the atrophy.

(c) *Permanent Spasm due to Lesions of the Trunks of Nerves.*—This is not a common cause of spasm of the muscles of the extremities; but that muscular spasm may arise in this way is proved by the rigidity of the face which not unfrequently occurs in old-standing cases of Bell's (or peripheral) paralysis of the facial nerve. It is no uncommon occurrence to find, after a severe and complete paralysis of one side of the face from a lesion of the trunk of the facial nerve (due to cold or other causes), that the muscles of that side, from being completely flaccid, become gradually contracted, and at length the face may be dragged over to the paralysed side; so much so, indeed, that it might be thought, from a superficial glance, that it was the healthy side which lacked action. This contraction in the paralysed muscles may be associated with more or less recovery of voluntary power over the muscles, but in some cases it is unattended by any recovery of power.

(d) *Hysterical Spasm.*—Tonic spasm of muscles is not uncommon in hysterical subjects, and when once established it may last for a long time. It may affect the arm or the leg—the latter more frequently than the former. It may involve one group of muscles alone, or all the groups of muscles in a limb. In the latter case, however, the contraction of certain groups generally overbalances that of the antagonistic groups. Thus in the arm, although all the muscles may be strongly contracted, the contraction of the flexors as a rule overcomes that of the extensors; the elbow and wrist become flexed, and the hands tightly clenched. In the leg the commonest variety of hysterical contraction is to have the thigh forcibly flexed on the trunk and the leg upon the thigh, the knee touching the abdomen and the heel being pressed against the buttock.

(e) *Tetanic.*—By this term is meant a tonic contraction of the muscles of the limbs, coming on more or less rapidly, involving in the majority of cases all the limbs, lasting from a few days to a few months, and almost invariably ending in a complete recovery. The spasm assumes a peculiar form; the arms are extended, but the fingers flexed at the metacarpal joints and the thumb adducted, the hand thus assuming a conical position. The legs are also extended, but the toes are flexed at the soles. The condition chiefly occurs in infants, in young people, and in suckling women. It may last from a few days to a few months. Its cause is unknown.

(*f*) *Permanent Spasm arising from Reflex Causes.*—Spasm from reflex causes is frequently mentioned in books, and considerable stress is laid upon the influence of reflex action in the production of spasm. Yet it is probably a much less frequent cause for permanent muscular contraction than is often thought. When it does occur, it more frequently affects the muscles of the face, jaw, or eyes, than of the extremities. Thus an obstinate trismus may be induced by the irritation resulting from a decayed tooth or from facial neuralgia, due to other causes. In the same way facial neuralgia may induce tonic contraction of the orbicularis palpebrarum. Spasm of one of the recti muscles of the eye, leading to strabismus, is not unfrequently met with as the result of the irritation of worms and from other reflex causes. In dealing with tonic spasms of the limbs we must be on our guard against falling back upon 'reflex irritation' as a cause in default of others. Although it is probable that permanent contraction of the limbs may occur from reflex irritation, such a sequence is exceptional.[1]

(*g*) *Permanent Tonic Spasm arising from Causes of Nervous Origin, but not included in the preceding Paragraphs.*—There are some forms of tonic spasm the causes for which are very obscure, and which it is difficult to include in any of the categories already mentioned. One of the most important of these spasms is tonic torticollis. It is rarely possible to indicate

[1] It will be understood that 'cramps,' which may notoriously arise from reflex causes, are not included in the category of tonic forms here dealt with.

any definite cause for this condition; the pathology is unknown, and no radical method of treatment has hitherto been discovered. The condition is one, however, which is in some cases capable of alleviation by the surgeon.

Another variety which must be included in the category of unclassed spasms is the muscular contraction producing strabismus, when this cannot be traced to a reflex cause.

B. *Conditions leading to Passive Contraction of Muscles without Spasm.*

(1) *Congenital Causes.*

Amongst these may be included many cases of club-foot and of a similar condition in the hands. The causation of club-foot has been considered elsewhere. Whatever theory we may adopt as to its mode of production, there can be no doubt that, in the large majority of cases, the muscular condition after birth is one of passive shortening, corresponding to the malposition of the foot, and that this passive shortening must be overcome before the foot can be replaced in its normal position.

(2) *Acquired.*

(*a*) *Due to the Unbalanced Action of Groups of Muscles where the Antagonistic Groups are Paralysed.*—In order that this condition may be brought about, it is necessary that certain groups of muscles in a limb shall be paralysed and flaccid, whilst their antagonistic groups are healthy, or are, at any rate, less affected than themselves. The disease in which this peculiar mode of distribution of paralysis is met with is that which results from a lesion in the anterior horns of grey matter in the spinal cord. One of the most common forms of this disease is known as 'acute anterior polio-myelitis,' or when it occurs in children by the more familiar name 'infantile paralysis.' The contraction in these cases is rarely very marked, but it may be in some instances sufficiently so to call for treatment. This is especially the case when the muscles on the front of the leg are paralysed, the calf muscles being healthy. The latter are then apt to become a little contracted, necessitating division of the tendo Achillis.

Another instance of the occurrence of this condition is seen in the paralysis of the extensors of the forearm, met with in lead poisoning. The hand assumes the well-known 'dropped-wrist' position, and after this has lasted some time the muscles of the front of the forearm are liable to become passively shortened, making it difficult to extend the wrist properly.

When the disease of the anterior horns is chronic, as is the case in progressive muscular atrophy, this unbalanced action of the healthy group of muscles is much less frequently seen.

(*b*) *Due to the Maintenance of a Paralysed Limb in a Shortened Position for a considerable Length of Time by Spasm.*—It not unfrequently happens that acute disease of the spinal cord will cause the limbs—generally the legs—to be maintained in a flexed or semi-flexed position in the manner already described. After a few weeks or a few months the disease may pass away, and all active spasm resulting from the disease of the cord will disappear. The muscles, however, from having been so long in a shortened position, will have become permanently contracted, and will require surgical treatment before the limbs can be straightened. The condition of limbs is, from the surgical point of view, the same when the contraction arises from this cause as when it arises from causes other than nervous. Its treatment will therefore be considered when the question of shortening of muscles from prolonged rest is gone into. It is very important to recognise this condition when arising from nervous causes; for a limb which has been for a considerable period the subject of active spasm, and the treatment of which by surgical means has been out of the question, may gradually pass into a state of mere passive contraction free from active spasm, when surgical treatment is absolutely necessary unless the patient is to be left a helpless cripple for the rest of his life.]

The remaining causes of deformity are—

Ankylosis,

Dislocation,
Contraction of skin fasciæ and ligaments, and
Relaxation of fasciæ and ligaments;
and these do not require any special preliminary remarks.

Nervous Mimicry or Hysteria.

This morbid condition of the nervous system, which disposes to the simulation of a great variety of diseases, is apt (as the reader is well aware) to give rise to difficulty in diagnosis both to the physician and the surgeon, and some of the affections dealt with in this volume are peculiarly liable to be associated with or imitated by this hyperneurotic condition of the individual. The author has not thought it necessary to add to these pages by attempting to enter fully into this subject of hysteria, but he is anxious that its importance should be fully recognised, especially when the surgeon is examining patients who present symptoms of affections of the spine and disease of the joints.

The lectures of Sir James Paget, and the essays referred to by him—viz. Dr. Russell Reynolds's, in the 'System of Medicine,' and Dr. Anstie's, in the 'Lancet'—contain the essence of nearly all that is known upon the subject. Dr. Shaffer, of New York, has also written very practically upon the 'Hysterical Element in Orthopædic Surgery.'

In several parts of this book reference to hysteria is made under the heading 'Diagnosis,' and it may be thought by some that sufficient details have not been given for the purpose of distinguishing the *imitation* from the real disease. This may be true, but such a course has been adopted because the simulations in hysteria are so varied that no exact rules for diagnosis can be drawn up, and because it is only by a careful study of all the symptoms of actual disease that a correct opinion can be formed in any given case.

CHAPTER II.

CLUB-FOOT.

Synonyms—*Pes contortus; Talipes*[1] (from *talipedare*, to walk imperfectly); French, *Pied bot*; German, *Klumpfuss*; Italian, *Piede torto*; Spanish, *Pié truncado.*

General Anatomical Character of the Foot.

Movements.—The ankle joint is a hinge joint (ginglymus), the natural movements being flexion and extension.

Lateral motion does not usually take place, but it is possible to a very slight extent when the foot is fully extended.

Flexion (as generally stated) may be performed to the extent of 15° to 20° from a right angle; extension to 20° to 25° or 30°; but the author has found the range of action in a healthy and well-formed individual to be—flexion 22° and extension 45°, as shown in fig. 1.

In children the foot can be flexed much nearer to the leg.

The movement between the calcaneum and astragalus is one of rotation and is very slight.

If the calcaneum moves forwards upon the astragalus, the form of the articulating surfaces causes the anterior part of the calcaneum to turn inwards, and *vice versâ.*

If the calcaneum advances while the astragalus remains fixed to the tibia, the outer part of the foot passes forwards and the toes are turned inwards.

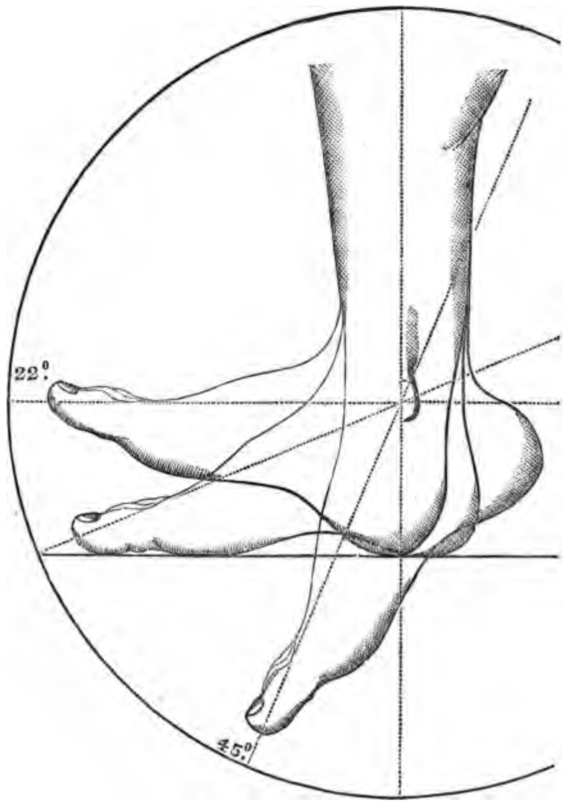
If the body of the calcaneum is *depressed* while the as-

[1] Suggested by Dr. Little as a generic term, but used originally for *Varus* alone.

tragalus remains stationary, the whole outer border of the foot is depressed with it, and the sole is turned inwards.

The *transverse tarsal* joint—formed by the calcaneum and

FIG. 1.



astragalus posteriorly, and the cuboid and scaphoid anteriorly —is the most movable joint of the tarsus.

When the anterior portion of the foot is depressed, the scaphoid descends obliquely downwards and inwards. The cuboid moves in a similar direction, but descends farther than the scaphoid. By these movements the antero-posterior arch of the foot is rendered more curved, and the toes are directed downwards and inwards; the outer side of the foot is depressed more than the inner, so that the sole is directed obliquely inwards.

If the anterior part of the foot is raised from its natural right-angled position with the leg, the outer is raised more than the inner side of the foot, and the toes are turned outwards, but these movements are very slight in comparison to those produced by *depression* of the foot.

The movements of the other joints of the tarsus are less important in reference to club-foot than are those which have now been described.

The muscles concerned in ordinary flexion are the *tibialis anticus* and *peroneus tertius*, and in extreme flexion the *extensor longus digitorum* and the *extensor longus pollicis*.

The muscles concerned in moderate extension are the *gastrocnemius*, *soleus*, and *plantaris*, and in extreme extension the *tibialis posticus*, *peroneus longus*, and the *extensor longus pollicis*.

Adduction is performed by the *tibialis anticus* and *posticus*, abduction by the three *peronei* muscles.

In the arrangement of the bones of the foot we find three distinct curves. Two of these—namely, the antero-posterior vertical curve and the transverse vertical curve—form the plantar excavation, and subserve to the strength and elasticity of the tarsus 'in a vertical sense.'[1]

The third is a horizontal antero-posterior curve formed by the inner half of the tarsus, its convexity presenting inwards.

A very practical distinction has been drawn[1] between the inner and outer half of the tarsus, the former being adapted for elasticity and for breaking the shocks which are transmitted through this part of the foot from the ball of the great toe to the leg, the latter being more rigid and straight and serving the purposes of the foot as a lever.

[1] H. O. Ward, *Osteology*, 3rd edition, Lond. 1876.

The plantar excavation of the foot is a feature of much interest to the surgeon. It is maintained mainly by the ligaments, especially the plantar, and also by the plantar aponeurosis.

The extent of this excavation is shown by the form of the impression which is produced by a wet naked foot upon a flat surface. Although the whole weight of the body be sustained by one foot, only a portion of the sole will touch the floor, and the wet impression will appear as shown in fig. 2.

Fig. 2.

Copy of an impression of the sole of a normal foot. The idea is adopted from Sayre's 'Orthopædic Surgery.'

Club-foot is a deformity characterised by a deviation of the bones of the tarsus from their normal relations with one another and with the leg, their unnatural position being maintained by a shortened condition either of one or more of the muscles, ligaments, or fasciæ in connection with the foot.

The origin of congenital club-foot, as well as the nature of abnormal muscular shortening, has already been discussed, but it may here be stated that club-foot may be the immediate result of—

1. Active muscular shortening—so-called spastic club-foot;

2. Muscular shortening from paralysis of the antagonists—so-called paralytic club-foot; and

3. Traumatic causes, including long-continued resting of the foot in an abnormal position.

The general appearance and conditions of paralytic cases are as follows :—The paralysed muscles are more or less atrophied; the vitality of the limb is lowered; the parts are cold and flaccid; the appearance of the skin is peculiar, the result of feeble circulation; chilblains and ulcerations are often present.

The general appearance and conditions of spastic cases is, as far as the tissues are concerned, that of health, except that they are often atrophied from long disuse.

Four chief varieties of this deformity are usually described.

1. *Talipes equinus*, in which the heel is raised and the toes depressed.

2. *Talipes calcanous*, in which the heel is depressed and the toes raised.

3. *Talipes varus*, in which the inner side of the foot is raised and the outer depressed, and the toes inverted.

4. *Talipes valgus*, in which the inner side of the foot is depressed, the arch obliterated, and the outer side of the foot raised.

Combinations of these chief varieties are also described as *equino-varus*, *equino-valgus*, *calcaneo-varus*, and *calcaneo-valgus*.

Relative Frequency of the Different Varieties.

The following statistics are quoted from Mr. Lonsdale's analysis of 3,000 cases of deformities treated at the Royal Orthopædic Hospital in Bloomsbury Square.[1]

	M.	F.	Total
PRIMITIVE FORMS.			
Varus.			
Of both feet	54	19	73
Of right foot	26	13	39
Of left foot	11	15	26
Valgus.			
Of both feet	21	19	40
Of right foot	13	5	18
Of left foot	7	5	12

[1] *The Lancet*, Sept. 1, 1855.

	M.	F.	Total
Primitive Forms—(*continued*).			
Equinus.			
Both feet spasmodic	21	17	38
„ paralytic	4	7	11
Right only spasmodic	20	18	38
Left only spasmodic	15	12	27
Right only paralytic	12	8	20
Left only paralytic	10	12	22
Traumatic equinus	3	4	7
Contraction of plantar fascia, both feet	3	3	6
„ „ left only	1	—	1
Calcaneus.			
Of both feet	2	3	5
Of left only	2	1	3
Of right only	4	3	7
Double	—	3	3
			396
Compound Forms.			
Equino-varus, both	5	2	7
„ right foot	6	6	12
„ left foot	5	2	7
Equino-valgus, both	3	3	6
„ right foot	7	2	9
„ left foot	5	7	12
Calcaneo-valgus, both	—	4	4
„ right foot	2	5	7
„ left foot	2	7	9
			73
Mixed Forms Affecting Opposite Feet.			
Valgus and varus	3	1	4
Calcaneus and varus	7	5	12
Equino-varus and valgus	2	3	5
Equino-valgus and calcaneo-valgus	—	1	1
Equinus and calcaneus	2	1	3
Equinus and varus	—	1	1
			26

Total Club-foot.

Primitive forms	396
Compound forms	73
Mixed forms	26
	495

Talipes equinus.

Origin.—It is the commonest form of acquired talipes, but is very rarely congenital.[1] As an acquired affection it may be the result —

1. Of *spasmodic action* of the muscles of the calf, which act upon the tendo Achillis, and sometimes, to a slight extent, of the deeper-seated layer.

The spasm of these extensor muscles overcomes the action of the flexors.

2. Of *paralysis* of the flexors of the foot, in which case the extensors contract from the absence of the usual antagonistic strength of the flexors.

3. Of long-continued extension of the foot, such as may occur from the pressure of the bed clothes during a long illness, or other causes.

4. Of the contraction of cicatrices, following wounds or abscesses in the muscles or neighbouring parts.

The exact position assumed by the foot differs according to circumstances.

1. If the anterior muscles of the leg retain their power, the toes will be extended when the foot is placed upon the ground, as in fig. 3.

2. If there is spasmodic action of the muscles on the anterior aspect of the leg, and also contraction of the flexor longus digitorum, the distal phalanges will become flexed, and the toes will assume a claw-like appearance,[2] as in fig. 4.

3. If the anterior muscles are paralysed and the foot not much used, the toes will become flexed, as in fig. 5.

But if the foot is used much, it may eventually assume the form represented in fig. 6.

If the muscles upon the anterior surface of the leg are not all paralysed, the foregoing symptoms will be modified, as when

[1] For the origin of congenital talipes see p. 7.

[2] *Club-foot*, by William Adams, 2nd edition.

the extensor proprius pollicis retains its power the great toe will be extended more than the other toes.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

In *Talipes equinus* the contraction of the extensor muscles of the foot may be only sufficient to prevent the foot being flexed beyond a right angle, or it may be enough to produce any degree of deformity between this 'right-angled' contraction and the position of the foot in fig. 4.

The term *Talipes cavus* is sometimes applied to cases in which the deformity consists chiefly or entirely in contraction of the plantar fascia.

Progressive Changes.—In spastic cases the following results may occur, which are chiefly the effects of locomotion :—

1. Widening of the front part of the foot.

2. Contraction of the plantar fascia.[1]

3. Adaptation of the deep ligaments to the altered position of the bones.

4. Projection of the astragalus on the dorsum of the foot.

5. The formation of bursæ, callosities, and corns upon the parts which have to sustain the weight of the body.[2]

6. Shortness of the leg and smallness of the foot from retarded development.

7. Inequality in the length of the limbs may produce lateral curvature of the spine.

In paralytic cases the above changes are modified by the loss of power in the anterior muscles.

The knee and ankle joints are often weakened by the laxity of the paralysed muscles. Consequently the ligaments yield, and the movements of the joints and the shape of growing bones become abnormal.[3]

Locomotion is impeded in proportion to the degree of deformity. One or more of the following symptoms may be present :—

In spastic cases :—

1. Lameness.

2. Fatigue after walking.

3. Shortened stride.

[1] The inner bands of fasciæ are often alone contracted, causing the anterior part of the foot to be more or less inverted.

[2] Bursæ may become inflamed and cause much trouble.

[3] See Little on *Club-foot*, p. 70.

4. Foot twisted outwards during progression.

5. *In paralytic cases* the foot is dragged, and the toes 'catch' upon any inequality of the ground.

In slight cases dancing or *ascending* stairs may be easy, but standing, walking, and *descending* stairs are always difficult, and cause pain.

In paralytic cases the heel is involuntarily drawn up higher when the patient walks than when the foot is at rest, because the gastrocnemius is unopposed by the anterior muscles of the leg.

Sometimes the retraction of the muscles proceeds so slowly that three or four years elapse before the child is prevented from walking. In these cases, if both feet are affected the child will flex the body forwards, bending the hip joints in order to bring the heels of the feet to the ground. Eventually progression becomes impossible.

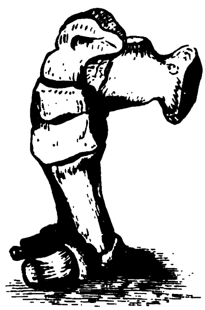
Morbid Anatomy.—The os calcis is raised more or less, and may even be in contact with the tibia. In the early stages of the deformity the depression of the anterior portion of the foot depends (generally) upon the raising of the heel alone. Subsequently, and probably to a great extent in consequence of use of the foot in this position, the arch becomes contracted, so that the deformity may come to depend as much upon a bend of the foot at the transverse tarsal joint as upon the elevation of the heel.

The astragalus is displaced downwards, and forms a projection upon the dorsum of the foot, the other bones of the foot having an abnormally downward direction. In thoses cases in which the bend at the transverse tarsal joint is present, the scaphoid is brought abnormally near to the os calcis, and the two bones are often in contact.

Mr. Chance has described a typical case in which the upper extremity of the fifth metatarsal bone was almost in contact with the os calcis, and a facet had formed on the os calcis behind the astragalus for articulation with the tibia. The articulating surfaces of the astragalus were also slightly altered.

In cases in which the patient has extended the toes during progression the proximal phalangeal bones form, in time,

FIG. 7.



Bones of the Foot of an Adult who had suffered from Talipes equinus (after E. J. Chance).

articular surfaces upon the normally superior surface of the metatarsal bones.

Various degrees of changes have been recorded,[1] but they are seldom, if ever, such as to interfere with restoration of the proper function of the member when the deformity is relieved by operation. Patients have been cured at 60 years of age in whom the deformity had existed from childhood.

In some old cases not relieved by operation the bones have been found after death unnaturally cancellous, and consequently light.

Ligaments.—The ligaments become contracted in the sole of the foot, and lengthened on the dorsal aspect. The astragalo-scaphoid ligament may be found much lengthened.[2]

The muscles which are contracted are chiefly and primarily those acting upon the tendo Achillis; secondarily, the flexor brevis digitorum, and in some cases the deep muscles of the calf.

[1] See *Club-foot: its Causes, Pathology, and Treatment*, the Jacksonian prize essay for 1864, by William Adams, F.R.C.S., second edition, 1873.

[2] For a careful description of the morbid appearance of some cases of talipes equinus see Nayler, *St. George's Hosp. Reps.*, vol. i.

When the claw-like appearance already referred to exists, the flexor longus digitorum will be found contracted.

Pancoast, of Philadelphia,[1] asserts that of the muscles acting upon the tendo Achillis the soleus is chiefly or only at fault; but the fact that the deformity is influenced by extension and flexion of the leg upon the thigh proves that contraction must exist in the muscles which are attached to the condyles of the femur, viz. the gastrocnemius and plantaris.

Diagnosis.—To detect the deformity the surgeon should raise the leg while the patient is in a sitting posture, and the knee must be depressed, so that the leg shall be straight with the thigh. If any flexion at the knee joint be permitted it will relax the *gastrocnemius* and allow more flexion at the ankle, so that a moderate degree of *talipes equinus* will disappear, or a severe *talipes equinus* appear less.

Talipes equino-varus.

This being merely a variety of *talipes equinus*, only a few remarks need be made in addition to the foregoing description.

FIG. 8.

Before treatment.

FIG. 9.

After treatment.

Spasmodic Talipes equino-varus (after W. Adams).

As in *talipes equinus*, the external appearances are modified according to the nature of the case.

[1] See *Lectures on Orthopædic Surgery*, by Louis Bauer, M.D., M.R.C.S., New York, 1868.

In spasmodic cases the foot assumes the appearance of fig. 8. In paralytic cases the appearance is as shown in fig. 10.

FIG. 10.

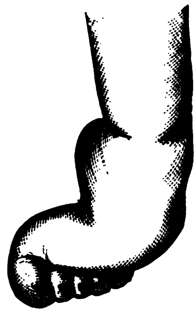


FIG. 11.

Before treatment. After treatment.

Paralytic Talipes equino-varus (after W. Adams).

Talipes equino-valgus.

The foot is everted, but the heel is not usually much raised. This deformity is so similar to *talipes valgus* that the reader is referred to the description of that variety.

Talipes varus.

Origin.—This deformity is generally congenital, but sometimes it is acquired.

Congenital Talipes varus.

This is the commonest form of congenital club-foot. The causes have already been discussed.

Position of Parts.—The part of the foot anterior to the transverse tarsal joint is turned inwards towards the other foot.

The inner side of the foot is drawn upwards.

The os calcis is drawn upwards posteriorly.

The sole of the foot is sometimes shortened by contraction of the plantar fascia.

The consequence of the foregoing conditions is that the anterior part of the sole of the foot has a more or less vertical position, and presents backwards.

The foot is shortened, partly from the deformity and slightly from arrest of development of the bones.

The heel is generally abnormal in shape, and small.

The internal malleolus is less apparent than in the normal foot, and may appear to be abnormally forward.

The external malleolus is in its natural position, or may appear to be moved backwards.

The dorsum of the foot is irregular, the astragalus being especially protuberant.

Progressive Changes.—The following may take place :—

1. Gradual increase of the deformity from use of the foot, the patient walking at first upon the outer side of the foot and

FIG. 12.

Posterior View. Anterior View.

A case of Severe Congenital Talipes varus in an infant (left foot).

FIG. 13.

A case of severe Congenital Talipes varus in an adult (left foot).

subsequently upon the dorsum. In the latter case the sole is turned more or less upwards.

2. Indentation of the sole of the foot; one furrow appearing opposite the transverse tarsal joint and another longitudinally; the latter being caused by the fourth and fifth metatarsal bones folding under the others (see fig. 13).

3. The formation of bursæ, callosities, and corns upon the parts which have to sustain the weight of the body.

Inflammation of bursæ sometimes gives rise to serious additional troubles.

Morbid Anatomy.—The *bones* are modified in shape, usually as a result of their development taking place in a deformed position, but sometimes their shape appears to be abnormal from an original malformation. The modifications vary in different cases, the variations being chiefly those of degree.

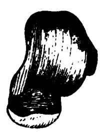
Glisson, Blumenbach, Scarpa, Colles, Mackeever, Palletta, Delpech, Tortual, Huette, Adams, Little, and others have described a variety of these modifications; the chief and most constant departures from the normal condition being as follows:—

The *scaphoid bone* is drawn inwards, backwards, and upwards by the tibiales muscles, so that its internal border is close to, or in contact with, the internal malleolus, to which in some cases it has been found adherent.

The *os calcis* is drawn upwards, the anterior part of the bone turned in the direction of the deformity, and the tuberosity turned outwards.

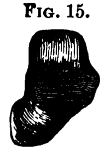
The *astragalus* is turned forwards and downwards and displaced from its socket, so that the anterior third or more of its

FIG. 14.



Healthy Fœtal (9th month) Astragalus, Superior Surface (after W. Adams[1]).

FIG. 15.



Astragalus from a Fœtus (9th month) with Severe Varus (after W. Adams[1]).

upper articular surface becomes superficial upon the dorsum of the foot. It is *rotated*, so that it is more in contact with the external malleolus than with the internal.

The neck inclines inwards.

The head of the deformed astragalus will be seen to be divided into two facets, the internal one articulated with the displaced scaphoid, the outer one being subcutaneous.

The external articular facet is often larger than usual, from its forward position having caused the malleolus to encroach backwards.

The internal articular facet is lessened.

The *cuboid bone* follows the scaphoid bone. Dr. Little has found its superior or external surface separated slightly from

[1] *Club-foot*, by W. Adams, *op. cit.*, p. 152.

the os calcis, and the plantar surfaces of the two bones approximated, but this bone is seldom altered much either in form or position.[1]

The alterations in position of the *cuneiform* and *metatarsal bones* and *phalanges* require no special description.

Malleoli.—Stromeyer, Delpech, Cruveilhier, and some other writers described a deficiency of the inner malleolus which they considered instrumental in the production of *talipes varus*; but neither Dr. Little[2] nor Mr. Adams[3] have met with this deficiency in their dissections, although Mr. Adams has seen it in an adult case.

The mistake has arisen, perhaps, from the fact that the displacement of the scaphoid bone prevents the internal malleolus from being distinguished in talipes varus.

The position of the foot and the oblique position of the os calcis causes the malleoli to *appear* displaced--the outer backwards and the inner forwards.

In the adult, in severe cases, Mr. Adams states that there may be a twisting of the lower end of the tibia, which alters the transverse relations of the malleoli.

The same author considers that 'the malformed condition of the astragalus is determined by the malposition' of the scaphoid bone and os calcis.

The *muscles* are generally apparently healthy in structure and fairly well developed at the time of birth. They may become atrophied, because they are thrown out of action by the deformity, but their complete use is rapidly acquired after the deformity has been removed.

In a few severe cases, however, the extensor muscles, and sometimes the peronei, have been found in a condition of fatty degeneration, and some of the muscles have been absent.

Upon the other hand, a case of hypertrophy of the tibiales and of the inner head of the gastrocnemius (the outer head being rudimentary) has been recorded by Mr. Adams.

[1] The author has seen a case in which the cuboid bone was much enlarged, and appeared to be the chief or only cause of the deformity, no contraction of the tendons being present.

[2] *Op. cit.* [3] *Op. cit.*

Fig. 16.

Talipes varus, seen from the front.

Fig. 17.

Talipes varus, seen from the inner side and from a slightly posterior position.
(Drawn by the Author from a dissection of the foot of a still-born child.)

The *tendons* are necessarily much changed in direction.

With regard to the tendons of the contracted muscles, the tibialis anticus passes inwards to its insertion into the internal cuneiform bone and metatarsal bone of the great toe.

The *tendon of the tibialis posticus* is pulled forwards in severe cases, and, in consequence of its having usually drawn the scaphoid bone close up to the malleolus, there is no change in its direction forwards to its insertion, as in the normal foot; but in less severe cases the tendon does pass forwards to some extent.

The Tendo Achillis.—In consequence of the oblique position of the os calcis this tendon is usually nearer to the outer side of the leg than is natural.

The *vessels and nerves* are not materially altered either in position or length, although slightly shortened, to affect the surgical relation of the parts.

The development of the bones is more or less retarded.

The displacement inwards of the metatarsal bones depends upon the tibialis anticus and extensor pollicis muscles, and also upon displacement of the navicular bone and upon lateral displacement of the cuboid bone.

The dorsal surfaces of the fourth and fifth metatarsal bones help to form the basis of support in progression.

The internal malleolus may become shortened, and sometimes a facet forms for articulation with the scaphoid bone, or the malleolus may be in contact with both the scaphoid and internal cuneiform bones.

Contractions of the ligaments and fasciæ in adult congenital talipes varus form important factors in causing rigidity of the deformity, which is contrary to the usual state of the case in infants.

Occasional Abnormalities.—Abnormal muscular slips and bifurcation of tendons may be present independently of the deformity.[1]

[1] Mr. Brodhurst records a case in which a slight sulcus separated the heel into two equal parts, and there were two Achilles tendons, both of which had to be divided.

Irregularity dependent upon the Deformity.—The tendon of the *tibialis anticus* crosses the tibia at a higher point than usual.

The tendon of the *tibialis posticus* is at first lodged in a groove *on*, rather than behind, the malleolus; this position is rendered more apparent by the position of the os calcis towards the fibula and the slight twisting of the inner malleolus forwards. It has already been observed that the tendon often proceeds straight down to its insertion into the *scaphoid* instead of taking its usual turn forwards to reach its insertion in the normal foot. The scaphoid is displaced backwards, so as to bring the point of insertion of the tendon quite close to the border of the malleolus.

Acquired Talipes varus

May result from—

1. Infantile paralysis.
2. Abnormal muscular contraction.
3. Traumatic causes.

The most frequent cause is infantile paralysis.

The *morbid anatomy* of these cases shows chiefly atrophic changes and defective development.

The *bones* are not so much altered as in congenital talipes varus.

In paralytic talipes varus there is sometimes paralysis of all the muscles below the knee, under which circumstances there is a natural tendency for the foot to twist inwards; or, if the peronei and extensor longus—and perhaps extensor pollicis—are paralysed, then the tibiales, being unopposed, contract.

Spasmodic cases of acquired talipes varus are rare.

The Contracted Muscles are the

Tibialis anticus.
„ posticus.
Gastrocnemius and soleus.
Flexor longus digitorum.

And sometimes the

Extensor pollicis and
Abductor pollicis.

The plantar fascia, as already stated, and even the ligaments, may also be contracted.

Diagnosis.—There is no difficulty in diagnosis.

Talipes valgus.

Origin.—This is nearly always an acquired, but is sometimes a congenital, deformity.

Congenital Talipes valgus.

The causes have already been discussed.

External Characters.—The arch of the foot is flattened. The inner margin approaches the ground; the outer is raised, and

FIG. 18.

a *b*

Congenital Talipes valgus in an Infant.

a. Profile view from inner side, showing the depression of the inner and elevation of the outer margin of the foot. *b.* Front view, showing obliquity of foot and prominence of inner ankle.

(After W. Adams.)

the anterior portion of the foot is everted. Sometimes, though rarely, the sole is turned backwards as well as outwards. The os calcis is frequently raised by contraction of the muscles of the calf.

Progressive Changes.—If the case remains untreated, pain and difficulty of walking occur much earlier in congenital valgus, and are more severe than in varus.

Morbid Anatomy.—The bones are not generally very much displaced.

Os calcis: tuberosity raised.

Astragalus: tilted forwards and downwards.

Scaphoid bone rotated, so that the internal part is depressed and the outer raised, leaving the upper part of the head of the astragalus uncovered.

The *cuboid* bone is slightly rotated outwards.

The effect of these deviations is that the arch of the foot is destroyed, and in severe cases a convexity is produced downwards. Two prominences are formed in the inner side of the foot—

1. Exposed portion of head of astragalus.
2. Inner end of scaphoid bone.

In very bad cases the foot is 'bent upwards upon itself from the transverse tarsal joint, and assumes a boat- or canoe-like form.'

The *ligaments* become stretched upon the plantar and inner side of the foot, and ultimately contracted on the dorsum.

The calcaneo-scaphoid ligament is particularly relaxed.

The *muscles*, as in congenital talipes varus, are usually healthy in structure.

The *tendons* are very slightly altered in position.

The muscles that are retracted are the peronei, and perhaps the extensor longus digitorum, and often also the tendo Achillis.

Sometimes the extensor pollicis and abductor minimi digiti are also contracted.

Non-congenital Talipes valgus

Consists essentially in a falling of the arch of the foot.

There may be muscular contraction, or the deformity may depend upon weakness of the structures only. In the latter case it is called 'flat' or splayed foot, or 'spurious valgus.'

Origin.[1]—

1. Spasmodic contraction of abductor muscles.
2. Paralysis of adductor muscles.
3. Weakness of ligaments and muscles.
4. Rickets.
5. Injury.
6. Disease of ankle joint and surrounding tissues.

[1] See paper by Ch. Roberts, *St. George's Hosp. Reports*, vol. vii.

7. Rheumatism.

Exciting Causes.—

Long standing.

Carrying heavy weights.

Sudden exertion, as in athletic exercises.

Progressive Changes.—1. The arch of the foot gradually sinks, until the whole surface of the sole touches the ground even independently of the weight of the body.

Fig. 19 shows the impression made by a normal foot when the wet sole is placed upon the ground.

When talipes valgus exists the impression extends more or less over the hollow space left upon the inner aspect, and if there happens to be muscular contraction the outer part of the foot does not impress the ground.

FIG. 19.

Copy of an impression of the sole of a normal foot. The idea is adopted from Sayre's 'Orthopædic Surgery.'

2. The instep becomes less convex.

3. The internal malleolus becomes more prominent and lower.

4. The scaphoid bone and astragalus protrude upon the inner side of the foot.

5. In severe cases the weight of the body is chiefly borne by the inner side of the foot, upon the scaphoid bone and internal cuneiform bones.

6. The muscles and other structures become stretched, and adapt themselves to the deformed condition of the foot.

7. And in some cases the abductor muscles contract as a secondary affection.

Although porters, waiters, and others who have to stand much, or who carry heavy weights, are the chief sufferers, the complaint is by no means confined to them, but may occur in any class and at any age.

Morbid Anatomy.—The *bones* are not much altered in relative position; but the *scaphoid* and *internal cuneiform* bones are nearer to the ground than natural, and the *astragalus* is slightly displaced in the same direction.

In *rachitic cases* the form of the bones may be modified.

Muscles.—In paralysis the *tibialis anticus* is usually affected, and also sometimes the tibialis posticus. If the muscles of the tendo Achillis are also paralysed, talipes calcaneo-valgus results.

Prognosis.—This deformity is often a very troublesome one, and its cure tedious; but otherwise the prognosis is generally favourable, unless dependent upon incurable paralysis or disease of the ankle joint.

The connection of talipes valgus with knock-knee is considered in Chapter XIII.

Talipes calcaneus.

Origin.—Usually acquired. It is the rarest form of congenital talipes.

It may be the result of—

1. Spasm (rare).
2. Paralysis.
3. Abnormal length of tendo Achillis from injudicious stretching after division of that tendon.
4. Disease or injury.

Position of Parts.—The os calcis is depressed, so that in walking the heel is the portion of the foot which first comes in contact with the ground. This is most marked in congenital cases, because in these the anterior part of the foot is more or less raised, and perhaps everted.

Progressive Changes.—In congenital cases there is seldom any tendency to an increase of the deformity.

In non-congenital cases, if from paralysis, as is usually the case, the condition of the foot depends upon the extent of the paralysis. If all the muscles of the leg are paralysed, the anterior part of the foot sinks as well as the heel, increasing the arch of the foot, and the leg becomes much atrophied.

Morbid Anatomy.—The os calcis becomes vertical, and the astragalus is carried into an oblique position, so that part of the tibial articular surface may extrude from the joint backwards.

The *ligaments* will be lengthened at the back of the ankle and contracted in front and in the sole of the foot.

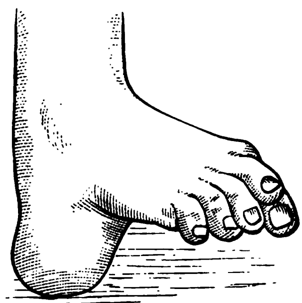
The plantar fascia may also be shortened.

Spasmodic Cases.—The *muscles* which may be contracted are the following:—

Extensor proprius pollicis,
„ longus digitorum,
Tibialis anticus, and sometimes the
Peroneus tertius.

The artificially produced deformity of the Chinese ladies' feet is described by Mr. Adams as being somewhat similar to ordinary talipes calcaneus, but differing in that the toes, being greatly depressed, are lower in position than the os calcis (which is also depressed).

FIG. 20.



Paralytic Talipes calcaneus (after Brodhurst).

Prognosis. — Cases of acquired talipes calcaneus being generally the result of contraction, from paralysis of the opponent muscles, their absolute cure is impossible; but relief can be given to the contracted muscles, and the heel can be supported by means of a very simple mechanical boot.

Congenital cases are usually spasmodic, and the prognosis is favourable.

Talipes Calcaneo-varus and Talipes Calcaneo-valgus.

These deformities do not require any description separate from that of talipes calcaneus. As light degree of inversion or eversion of the anterior portion of the foot, in addition to the depression of the heel, is more common than pure talip calcaneus.

General Remarks upon the Treatment of Congenital and Noncongenital Talipes.

The objects to be effected are—

1. To remove the deformity.
2. To restore the functions of the limb.

1. *To Remove the Deformity.*

The chief means at our disposal are the following:—

1. *Manipulations*, the foot being daily stretched towards a normal position.

2. *Bandaging to Splints.*—Metal splints padded and bent away from the deformity; or splints partly shaped to the normal form of the foot, and the foot stretched by bandages towards the splint; readjustment being effected every second, third, or fourth day.

3. A plaster of Paris casing applied to the foot after it has been stretched towards a normal position, and readjusted every few days.

4. Forcible reduction of the deformity, the foot being then fixed by a plaster of Paris or other firm bandage, and so retained for about six weeks.[1]

5. Stretching the foot towards a normal position by *elastic bands*, which are placed so as to act as nearly as possible in the same line as the muscles which are extended, each elastic cord being fastened by adhesive plaster, the one end to the foot and the other to the leg.

6. *Elastic bands* to act as above, but attached to a movable shoe (Sayre and Bauer).

7. *Scarpa's shoe* and its various modifications, the principles of which may be described as follows: A boot attached to the foot in its deformed position, an upright iron bar attached by straps to the leg, and a rack joint or joints, moved with a key, by which the boot, and with it the foot, can be forcibly moved in the desired direction. Springs may be combined with this boot. The heel

[1] Ogston, *Med. Rec.* vii. p. 37.

strap is used to retain the foot in the boot when attempts are made to flex the foot. Or a plain boot with a single upright bar and strap attachment to the leg, with a joint at the ankle which may be rack, free, or with a stop in one or other direction, with variously arranged straps for pressure.

8. Osteotomy.

9. Tenotomy and subsequent extension of the new tendon.

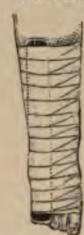
Many of the complicated apparatuses which have been invented are unnecessary to the successful treatment of these deformities.

Much more depends upon the skill of the surgeon in adapting simple methods to meet the requirements of individual cases than upon the exact construction of the appliance he uses.

FIG. 21.

FIG. 22.

FIG. 23.



In treating infants and young children the deformities may generally be improved and often cured by means of the simple metal splint and bandaging.

In cases of talipes varus, for instance, the malposition of the foot may often be overcome by such means, although the retraction of the heel generally necessitates the division of the tendo Achillis.

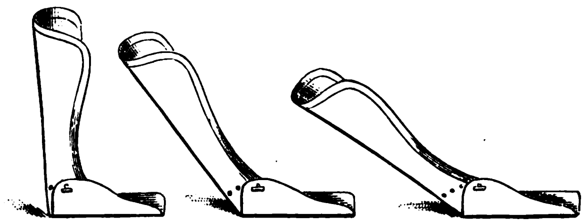
Fig. 21 shows an adaptable iron splint bent away from the deformity.

Fig. 22 shows the foot bandaged to the splint.

Fig. 23 shows a subsequent stage in the treatment, an improvement in the condition of the foot having allowed the alteration of the splint to a straight position.

Dr. Little's tin splints may be used. Some are made so that they may be adjusted for talipes equinus, talipes equino-varus, or other conditions.

FIG. 24.



Whatever splint is used, it must be carefully padded, and adjusted so that slight traction may be brought to bear upon the deformity. The splint should be removed often and readjusted.

The Elastic Band Treatment.—Apparatuses with various arrangements of elastic bands, as used by Barwell, although attractive in theory, have not proved so successful in practice as other appliances. There is great difficulty in regulating the pressure so that sores are not produced by the constant tension, and such modes of treatment possess no advantage over those which are more simple. In fact, they are quite incapable of overcoming the resistance offered in severe cases, and in paralytic cases if there is any tendency to recovery from the paralysis, the elastic band will interfere with such recovery by removing from the muscles the natural stimulus to their action.

Simplicity and lightness of the retentive apparatus are important qualities, and therefore Scarpa's shoe in its original form should never be used, and even in its modified form it is only necessary in severe cases.

Osteotomy.—The operation of removing by the chisel or saw a wedge-shaped piece from the tarsus as a cure for the deformity caused by talipes equinus, talipes equino-varus, and talipes varus, has during the last few years been performed in this country by several surgeons.

To take the last condition first—talipes varus—it may be sufficient to remove the cuboid bone alone, but this will not always suffice; it may be found necessary, in order to bring the foot into its proper position, to excise portions of the os calcis, astragalus scaphoid, cuneiform, and outer metatarsal bones. To remove the deformity which presents itself in cases of talipes equinus an equally severe operation has to be performed.

It is needless to say that to admit of the removal of such a large part of the bony arch of the foot a considerable wound must be made, many synovial cavities and sheaths of tendons must be opened, and the tendons themselves divided, but not subcutaneously.

Of several hundreds of cases of club-foot which the author has either seen treated by others or has dealt with himself, such a formidable proceeding has not been necessary for the cure of the patients.

The most rudimentary knowledge of the etiology of the various forms of blood poisoning ought to make even a bold surgeon hesitate before exposing a patient to the risks of absorption of the septic debris, which must of necessity remain in such a wound as I have described.

Theory in this case has been corroborated by fact. Mr. Richard Davey, who has been the chief advocate for this mode of treatment, states that he has now operated upon a series of fourteen cases in which he found it necessary to resort to this proceeding for the cure of talipes varus and talipes equinus.[1] Of these fourteen cases one died from the effects of the operation. Of three cases operated upon in this manner by König one died from the effects of the operation.[2] Of thousands of cases which have been dealt with by the ordinary orthopædic methods of treatment not one has terminated fatally.

Unless in the near future those surgeons who advocate the chisel and saw method of curing club-foot can publish a much more satisfactory series of operations than those quoted above,

[1] At a meeting of the Clinical Society, reported in the *British Medical Journal*, December 24, 1881.

[2] *Lancet*, December 24, 1881.

the author, for his part, fails to see that the operation in the case of children is in any way justifiable.

In Mr. Davey's cases the majority of the subjects were under sixteen years of age; one child was only sixteen months old. It is within the daily experience of every practitioner of orthopædic surgery that in treating such young children, whose muscles and ligaments are in a growing and ductile condition, success in restoring the deformed feet to their normal shape is most certain and safe without osteotomy.

It has, however, been urged by those who are in favour of surmounting difficulties by cutting the Gordian knot, that this does not obtain in older people. To this, however, it must be replied that talipes in all its forms has been perfectly cured by the patient and judicious use of well-devised orthopædic apparatus, combined with the division of those tendons and fasciæ which require it, in a large number of adults of various ages.

Tenotomy.—This operation, upon which the modern treatment of club-foot is based, is a highly important method, but yet one which must not be employed indiscriminately, and *the surgeon should never perform it unless both he and his patient are prepared to thoroughly carry out the after-treatment.*

Experience alone can guide us in deciding whether tenotomy is or is not necessary in cases that are not very severe; but it may be laid down as a rule that rigidity of the affected muscles is a surer indication for tenotomy than deformity.

In some cases, for instance, a foot, when handled, can be to a considerable extent forced towards a normal position, whereas in other cases, where perhaps the deformity is less, very little alteration of the position can be effected by manipulation. Tenotomy is more called for in the latter cases than in the former.

The Manner of Performing Tenotomy.

It is usually most convenient to divide all tendons and fasciæ from below towards the skin, but if the surgeon prefer to do so he may insert the knife between the tendon and the skin, and cut inwards.

The usual form of knife used is that depicted in fig. 25. The exact shape and dimensions which are most desirable are matters of opinion, but the blade should not be less than an inch in length and $\frac{1}{8}$th of an inch in width.

FIG. 25.

The patient being placed in a convenient position, lying upon a table, the leg not to be operated upon is to be flexed upon the thigh and held out of the way by an assistant. The affected leg is to be managed by another assistant. The latter grasps the foot with one hand and the leg with the other, and stretches the tendon while the surgeon divides it.

The knife should be inserted in tenotomy for club-foot upon whichever side of the tendon is most convenient to the operator, except in the case of the *tibialis posticus*, when it must be passed between the tendon and the bone.

The knife should be introduced flatly, beneath, and as close to the tendon as possible, and then its cutting edge turned to the tendon and worked towards the surface.

The assistant who holds the foot tightens the tendon firmly during the operation, and carefully relaxes his force as the tendon is nearly cut through, and this carefulness is the more necessary as tendons differ very much in their relative toughness. A very tough tendon requires the knife to be used with a great deal of force, and if the assistant should allow the tendon to give way too suddenly the tenotome would be very likely to cut through the skin.

The tendon having been divided, the knife is withdrawn, slight pressure in the course of the wound with the finger following its exit. A pad of lint is placed over the puncture and fixed with plaster, and the whole leg is covered with a roller bandage. The foot is then bandaged to a splint, either in the deformed or in a slightly less deformed position than it presented before the operation.

The most useful kind of splint is that made of thin sheet iron or tin, which can be bent to the required angle. The splint should be covered and padded, and is not to be placed *over* the wound.

The foot should remain untouched for four, five, or six days, during which time the patient must keep the limb in a raised position and is to avoid all use or disturbance of the parts. Extension may then be commenced, and the foot gradually brought to its natural position.

In spastic cases the normal position may be reached in two or three weeks, but in paralytic cases in not less than six or eight weeks.

When there is much ligamentous rigidity, as in severe cases of congenital varus, a difficulty or impossibility is found in obtaining the required length before complete reunion has taken place, and re-division of the tendon sometimes becomes necessary.

Accidents that may Happen in the Performance of Tenotomy.

1. Penetration of the skin covering the tendon, making an open wound.

Treatment.—The wound is to be immediately closed and the foot bandaged to a splint as if the accident had not happened, and if no symptoms occur to call for examination the parts should be left untouched for seven or eight days, when the wound will probably be found to have healed by first intention.

2. Inflammation of the sheath of the tendon has been recorded, but will not happen if the knife be clean.

3. Wound of the posterior tibial artery or internal plantar artery.

Treatment.—Compress and bandage kept up for about two weeks.

4. False aneurism.

Treatment.—Carefully applied pressure, or, that failing, cutting down upon and tying the artery.

Imperfect union after tenotomy may occur from—

1. Constitutional weakness.
2. Bad after-treatment.
   - *a.* Too rapid stretching.[1]
   - *b.* The stretching being left to nature.
3. Local depression of vital powers from cold in paralytic cases.

Reunion of Divided Tendons.—Hunter, Mayo, Von Ammon, Guerin, Pirogoff, Koerner, Paget, Adams, Brodhurst, Savory, Billroth, and many other surgeons have experimented by performing tenotomy upon various animals.

The results of the post-mortem examinations of these animals prove—That the space between the ends of the divided tendon soon becomes filled up by plastic matter and serum; that the exudation and the cellular tissue around the ends of the divided tendon quickly grow rich in blood vessels, and that the inflammatory new formation surrounds and unites the ends of tendon, just as callus surrounds and unites the ends of a fractured bone; that this provisional union soon becomes firm, being changed into connective tissue; that the neoplastic tissue which has been developing in the stumps of the tendon combines with the intermediate substance, and this substance contracts gradually and strongly, assuming at last exactly the character of tendon; that this is the natural process under favourable circumstances, but injudicious interference with the parts, injuries, and extravasation of blood may modify the progress of reparation.

It is during the first stages of the above process only that elongation of the uniting medium can be effected.

Mechanical Treatment after Operation.—The apparatus employed for extending the new tendon and maintaining the foot in its normal position will be described in dealing with the different forms of talipes.

[1] This accident has occurred to the tendo Achillis as a result of immediate and full extension after tenotomy and the application in that position of a plaster of Paris bandage. Talipes calcaneus resulted.

2. *To Restore the Functions of the Limb.*

The loss of function may be the consequence of—

1. Prolonged inaction.
2. Paralysis.

In the first class of cases the muscles usually soon regain normal power when brought into proper action, but cases have been recorded in which the muscles, having undergone fatty degeneration, were not able to thoroughly regain their power.

The relief of contracted muscles by tenotomy acts very favourably upon the nutrition of the affected parts, but friction with stimulating liniments, or alternate hot and cold water bathing, will hasten the restoration of the parts to a healthy condition.

2. *The Treatment of Paralysed Muscles.*—During the existence of *active* disease of the nerve centres the case belongs more to the physician than the surgeon, so that one of the most important points for enquiry is with regard to possible sources of nerve affection.

The reader is referred to the remarks already made upon this subject, p. 17 *et seq.*

Active disease having ceased, both general and local treatment may be adopted.

1. *General Treatment.*—This must depend upon the condition of the patient, and must be conducted upon general principles.

2. *Local Treatment.*—The warmth of the parts must be maintained by woollen stockings or other means.

Active and passive movements, shampooing and friction with stimulating liniments, and hot-water bathing, the stimulation being employed in the course of the nerve trunks supplying the limb.

Electricity has received a great deal of attention, perhaps more than its due, during the last few years. Its merits and demerits will not be discussed here, but it may be observed that its value has doubtless been overrated, and it is possible that the contractile power of muscular fibres may, in some cases, be injured by too much electric stimulation.

If the paralysis has been caused by injury, or by pressure upon the nerve centres or in the course of the nerve trunks, the case must be treated upon general surgical principles.

Treatment of Talipes equinus.

The treatment depends upon the cause, and upon the condition of the muscles.

If the deformity be due to *paralysis of the flexors*, and the foot can be flexed by the hand of the surgeon, the paralysis should be treated upon the general principles of treatment already stated, and an apparatus to support the foot in its natural position adapted. Such apparatus serves the purpose of removing the deformity; it also prevents the extensor muscles from contracting, which would otherwise happen in the process of time.

FIG. 26.

FIG. 27.

The apparatus consists of the following parts :—a strong leather laced boot; an upright iron bar attached to the sole and fastened by a strap below the knee, with a stop joint at the ankle to prevent extension; an instep strap to retain the heel in its place; and a T-shaped strap to retain the foot in place with the iron upright.

If those muscles of the thigh which extend the leg be involved in the paralysis, the iron upright must be made long enough to reach and be attached to the thigh, a joint being provided opposite the knee, which is fixed for walking, but possesses a slip joint which can be released for sitting.

If there exists a *laxity of the knee joint*, so that free rotation takes place, the iron upright must be continued upwards to a pelvic belt, a joint being provided to allow of flexion and extension.

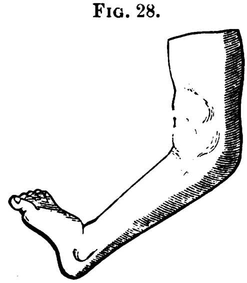
If there is preternatural extension of the leg (fig. 28), a stop joint must be made at the knee, to intercept forward action.

Treatment of these cases should not be delayed, as the deformity is sure to increase if left to itself.

If the muscles of the calf have become contracted, the tendo Achillis must be divided as described below.

Restoration of the foot to its proper position, and support as above described, is advantageous, as it at once facilitates locomotion, and it also gives the limb the best chance of recovery.[1] Yet, however favourable the symptoms may appear to be, some amount of paralysis and deficient development nearly always remains. The muscles of the calf, however, usually increase in bulk after operation, and the growth of the whole leg is favoured by the tenotomy. Even if the deformed foot is shorter than the sound one, it will be advisable to relieve the contracted muscle without delay, in order to avoid those structural changes in the joints which will otherwise continue to increase the lameness and the deformity.

FIG. 28.



After E. J. Chance.[2]

[1] It may be well to state that an instrument, properly used, cannot interfere with the growth of a limb.

[2] *Bodily Deformities, op. cit.*

If the case has been complicated by a wound or an abscess, bands of adhesions will perhaps exist, and will require division.

In spastic cases of talipes equinus, i.e. in those dependent upon spasmodic abnormal muscular contraction, unless the contraction is recent, tenotomy should be performed, even in slight cases, as no treatment without this operation will prove permanently beneficial.

Operation.—Before operating the boot that will be necessary for the after treatment should be procured, so that it may be ready for use when required.

If the plantar fascia is contracted it should be divided before the tendo Achillis, because the tarsal deformity can be more satisfactorily dealt with while the tendo Achillis remains tense than it can be when both operations are performed at the same time.

The tense tendo Achillis fixes the posterior portion of the arch of the foot, so that resistance is afforded for stretching out the fascia.

Division of Plantar Fascia.—The assistant stretches the fascia by steadying the heel with one hand and extending the anterior portion of the foot with the other. The surgeon passes the knife beneath the contracted band of fascia from the inner side and cuts towards the surface. The after treatment differs from that employed in tenotomy in that extension should be commenced at once, and the foot should be bound to a flat splint applied to the sole of the foot.

Division of the Tendo Achillis.[1]—The patient having been placed in the prone position, with his feet projecting beyond the edge of the table, an assistant should stretch the tendon by endeavouring to flex the foot.

The tenotome is then to be introduced with its flat surface parallel to the tendon from half an inch to an inch above the os calcis. Either side of the tendon may be chosen for the introduction of the knife.

[1] Sometimes the abductor pollicis or the short flexor of the toes requires division also.

The contraction of the toes, which generally accompanies this form of club-foot to a greater or less extent, usually succumbs to division of the tendo Achillis. If the toes remain in malposition, straps applied to individual toes for a time usually suffice to cure them. It is very rare that division of the tendons of the toes becomes necessary.

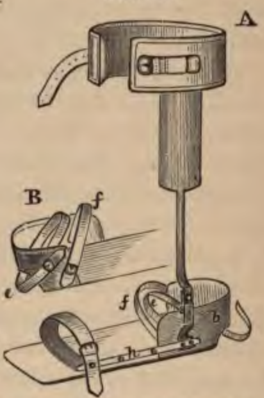
The treatment immediately after operation has been described above. After the foot has remained quiescent for five, six, or seven days extension is to be commenced.

Apparatus.—The same apparatus described on p. 58 for paralysis of the flexors, having, however, a rack joint instead of a stop joint at the ankle, is to be worn.

FIG. 29.

Tamplin's Modification of Scarpa's Shoe. (After Adams.)

FIG. 30.



Adams's Modification of Scarpa's Shoe.

Scarpa's shoe and various modifications of it are employed by some surgeons, but the boot described above is equally useful for the majority of cases, and much less elaborate, less expensive, and less likely to get out of order. This instrument should be worn at night as well as during the day. The more severe and complicated cases may require other apparatus.

Mr. Adams has introduced a modification of Scarpa's shoe, which has a joint opposite the transverse tarsal joint of the foot to bring force to bear upon contraction of the plantar arch, as he considers that this part of the foot is generally involved.

Mr. Adams's modification (fig. 30) differs from Tamplin's (fig. 29) in that the circular ankle-strap *g* is dispensed with as useless; *b*, the heel plate, is much diminished in size, to avoid pressure in lateral movement; *e*, the heel strap, has its power greatly increased by passing directly backwards through an aperture in the heel plate and sole, instead of transversely across the front of the large heel plate, as in fig. 29. The aperture is also useful to enable us to ascertain whether the heel is in its place. *h*, a straight bar, is substituted for a spring; it acts as well and is less in the way. The side bar *h* is used when there exists any inclination of the foot to turn inward.

Mr. Fisher has added to this apparatus by having a screw adapted to produce elongation or shortening of this anterior portion of the sole plate.

The time taken in restoring the foot to its natural form must depend upon the reparative process and the divided tendons. This may vary from fourteen days to six or more weeks. In some cases the development of firm tendon is so rapid that it even becomes necessary to divide the tendon a second time.

The shape of the boot is gradually altered by the cog-wheel joint at the ankle to the necessary angle.

Occasionally, after the foot has been relieved from the chief part of its deformity by division of the tendo Achillis, it is found that the tendons of the *flexor longus pollicis* and the *extensor proprius pollicis*, one or both, are tense.

This tension may succumb to stretching, but tenotomy is sometimes necessary.

After treatment has been carried on for a time there may be a disposition towards talipes valgus. This may depend upon long-retained position, or upon paralysis of the *tibialis anticus*, or upon contraction of the *peronei*. Careful adaptation of the shoe, and perhaps passive exercises, generally suffice to overcome this complication, but it may become necessary to divide the peronei.

The boot should be worn for a long time after the foot is restored to its proper position; and, as strength and normal function of the parts is gradually regained, the rack joint may be changed to a stop joint, and eventually to a free joint, the case being dealt with according to its progress, and this progress differs in rapidity or slowness in every case.

Prognosis.—*In paralytic cases* the deformity can be relieved, but the restoration of muscular power is uncertain. After infantile paralysis there is generally a tendency to recovery, and removal of the deformity by tenotomy favours this tendency.

In spastic cases, should the deformity have existed for many years, the anterior muscles of the leg will have partially lost their tonicity and power of action in consequence of their long-continued extension and inaction. But this deficiency is usually soon remedied by use, shampooing, and frictions with stimulating liniments, except in those uncommon cases in which some degeneration of muscular fibre has taken place, a condition which cannot be determined before the operation. The operation, however, cannot *lessen* the muscular power, but, upon the contrary, affords it the best chance of recovery.

Treatment of Equino-varus.

First the varus should be treated, and subsequently the equinus. The varus may often be remedied without tenotomy, but the equinus requires division of the tendo Achillis. If the case is very severe, it may be necessary to divide the treatment into three stages.

Stage 1. Division of the tendons of the tibiales muscles, and perhaps the anterior part of the internal lateral ligament (Adams), and bandaging the foot to a straight outside splint.

Stage 2. Division of the plantar fascia and subsequent mechanical extension of the deep plantar ligaments. This second stage is the most tedious one and requires great care.

Stage 3. Division of the tendo Achillis and the necessary after treatment, as already described.

The modification of Scarpa's shoe as used by Mr. Adams, or the boot already described for equinus, may be employed for the mechanical after treatment.

Treatment of Talipes varus.

The objects to be accomplished are, firstly, to remove the inversion of the foot and change the case into one of talipes equinus; and, secondly, to remove the talipes equinus.

Congenital Talipes varus.

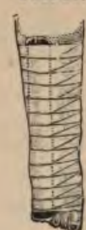
As already stated in the general remarks upon treatment, the first part may often be accomplished by assiduous bandaging to a splint, without tenotomy. But the treatment of the second part nearly always requires an operation.

A padded metal splint, as shown in the figure, is applied to the leg and foot, and bent slightly away from the direction of the deformity; and the foot and leg are then bandaged so that the position is slightly rectified.

Fig. 31.

Fig. 32.

Fig. 33.



After a few days the splint is to be removed, altered in shape, made straighter, and reapplied as in fig. 32.

This process is repeated again and again until the foot is brought into a straight position with the leg, as in fig. 33.

It must be kept in this position until all apparent tendency to inversion is overcome. When this stage is reached, the contraction of the heel upwards, if such exists, must be dealt with. For this purpose, if the contraction is slight, the metal splint or Dr. Little's tin varus splint may be employed, which can be altered in shape as the case progresses.

Whatever kind of splint is used it should be padded, attached to the ankle with strapping, bandaged to the foot, and adjusted and readjusted every few days as the case progresses.

Subsequently, the boot described and figured on p. 59 is to be worn, but with a cogwheel joint to move in the direction of flexion and extension. Eventually the joint may be altered to one with a back stop only. The **T** strap is to be placed upon the outer side of the foot.

When the deformity will not succumb to bandaging and splints, tenotomy must be performed.

Age at which Tenotomy should be performed.—It is the rule

FIG. 34.

Dr. Little's Varus Splint.

with the majority of orthopædic surgeons to commence treatment as early as practicable, even to perform tenotomy when the child is but a few weeks old, and Dr. Little records a case of operation upon a child twenty-four hours after birth, of which proceeding he states his approval.

This practice is supported upon the following principles :—

1. That the longer the parts remain deformed the more difficult and tedious becomes the treatment.

2. That it is desirable to operate before the period of teething, so that interruption from the various effects of this process may be avoided.

3. That delay retards the ultimate development of the muscles of the leg.

Mr. Chance, however, holds different views upon this subject, and his very large experience gives great weight to his opinion. He will not perform tenotomy until the time arrives when the child is beginning to try to walk. His reasons for waiting are as follows :—

That delay does not retard the process of cure nor make it the less effectual.

That if the child be operated on while very young, much expense is incurred by the necessity of frequently procuring new mechanical apparatus to accord with the rapid growth of the child's feet.

OPERATIONS.

The instructions already given for operating (see p. 54) may be applied, with certain modifications, to this variety of talipes.

The first stage consists in division of the tendons of the *tibialis anticus*, *tibialis posticus*, and sometimes of the *extensor longus pollicis*.

The second stage, if necessary, commencing about three or four weeks after the first, consists in division of the plantar fascia.

The third stage, after another period of three or four weeks in children, and of eight or ten weeks in adults, consists in division of the *tendo Achillis*.

The object of dividing the operations into these stages is for the purpose of retaining the ankle joint in a sufficiently fixed position for extension to be brought to bear upon the divided structures.

The Tendon of the Tibialis Anticus is to be divided over the ankle joint at the point where it can be felt most prominent. This tendon will be found rather nearer to the internal malleolus than in a normal foot.

The Tendon of the Tibialis Posticus.—The proximity of this tendon to the posterior tibial artery necessitates great caution in dividing it.

Dr. Little's plan, introduced in 1842, is as follows :—

By making the tendon tense it may usually be felt just above the internal malleolus. But in fat children there may be a difficulty in feeling the tendon, in which case a point should be selected '*exactly midway between the anterior and posterior borders of the leg*' on its inner aspect, and three-quarters of an inch above the lower extremity of the internal malleolus.

The knife is to be passed downwards close to the bone for half an inch or more in a fat child. The saphena vein and nerve are to be avoided anteriorly, and the posterior tibial artery and nerve are to be avoided posteriorly and deeply.[1]

In this operation the first object is to open the sheath of the tendon, after which the knife is to be withdrawn, and a blunt-pointed tenotome introduced until it is felt to be more or less fixed between the bone and the tendon.

Fig. 35.

Blunt-pointed Tenotome.

The flat side of the cutting-knife having been introduced parallel with the bone, the edge should now be turned towards the tendon, and while the assistant turns the foot outwards, so as to make the tendon tense, the surgeon depresses the handle of the knife slightly, and the tendon is readily divided. The same cut usually divides the *flexor longus digitorum*; but if this latter muscle is very tense it will require a somewhat deeper cut, as its tendon is placed more posteriorly, muscle fibres being in conjunction with the tibial tendon.

[1] Syme advocated the division of this tendon 'a little below and anterior to the tip of the internal malleolus,' but the point of attachment of the tendon to the scaphoid being in contact with the internal malleolus, as Mr. Adams and others have shown, the operation cannot be performed in the position recommended, at least not in cases *which are sufficiently severe to require tenotomy*. Syme divided the tendon after drawing it forwards by placing the foot in a more natural position, but in such cases treatment can be satisfactorily carried out without tenotomy.

The surgeon may feel the vibration of the tendon giving way before the knife, but the assistant, who usually feels a sudden relapse in the tenseness of the structures, is better able to determine that the tendon or tendons have been divided.

Some surgeons now discard the blunt-pointed knife, puncturing the sheath and dividing the tendons with the same sharp-pointed tenotome, but the practice is not so safe as the one described above, for the artery might be pricked or divided.[1]

Mechanical Treatment after Operation.

The apparatus has to oppose: firstly, the inversion of the foot; secondly, the contraction of the arch of the foot (when it exists); and thirdly, the contraction which raises the heel.

The first stage of treatment may in infants and young children be pursued as follows:—The muscles having been divided, and the foot bandaged to a splint for several days, as described at p. 54, an outside straight splint reaching above the knee and below the foot is to be applied with a roller bandage from above downwards, the foot being drawn towards the lower end of the splint.

FIG. 36.

Gently and gradually, and day by day, must the foot be drawn outwards until it is in a straight line with the leg. The splint should be removed and reapplied every second or third day. This part of the treatment will take from two to three weeks.

The treatment after division of plantar fascia is described at p. 61.

After the *tendo Achillis is divided* the treatment might be carried out in the same manner as described under talipes equinus, but we still have to deal with the tendency to inver-

[1] A *bistouri caché* may be used instead of two separate knives, if desired.

sion as well as with extension, and a great variety of mechanical instruments have been devised to fulfil these combined objects.

The chief difficulty is to avoid the production of sores from continuous pressure upon any one part of the foot in these cases. Mr. Adams uses a shoe which he considers a modification of the old Scarpa's shoe. It consists of—

1. A metal trough for the thigh, to steady the apparatus (*a*) (fig. 37).
2. Another trough for the leg (*b*).
3. A sole plate (*c*) moving by a cog-wheel joint in the direction of flexion and extension.
4. A strap to pass over the ankle joint.
5. A strap to pass over the instep.
6. Another strap to pass over the toes.

Fig. 37.

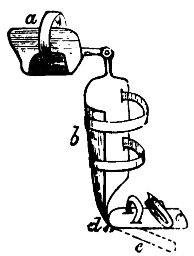
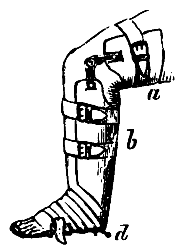


Fig. 38.



Mr. Adams's Infantile Varus Splint.

a. Thigh trough. *b.* Leg trough. *c.* Sole plate moving in the direction of flexion and extension from *e* to *c* (fig. 37) by a cog-wheel *d*, placed behind the heel.

Fig. 38 shows the splint in position, the foot having been brought to a right angle with the leg by the use of the cog-wheel *d*.

The outer side of the leg trough is flat and acts like an outside splint. The toe strap of webbing acts from a rectangular steel bar set off from the outer side of the sole plate, and thus is enabled to counteract any tendency to relapse of the inversion during the treatment of the talipes equinus that remains. Tamplin's splint does not possess a thigh piece, and in place of the fixed rectangular steel attached to the outside it possesses a spring.

In from two to three weeks the foot can be worked up to its natural position by action of the cog-wheel joint, and then passive motion can be commenced, and the varus splint used simply as a retentive apparatus. At the end of the fourth or fifth week, if the tendo Achillis feels strong, the varus splint may be substituted during the day by a leather boot with a light straight bar attached to the inner side, provided with a stop joint to limit extension, an outside **T** strap, and an instep strap—the same kind of boot that is used for paralytic equinus and represented in figs. 26 and 27—or this boot may be used with cog-wheel joint or joints.

Mr. Henry Baker has invented an improved form of Tamplin's varus splint for difficult cases in children above the age of infancy, differing from Tamplin's in several important points, but especially in that the part of the instrument which presses upon the outer part of the foot is formed of a movable pad, so that injury from too much continual pressure at one part is avoided.

Mr. Baker's apparatus is very useful in some cases. The modified Scarpa's shoe commonly used (Tamplin's), and also Mr. Adams's modification, have already been figured at p. 62.

For adult cases, in which walking has always much increased the deformity, Dr. Little invented a modification of Scarpa's shoe, which allowed the joint at the ankle to be set free in order to employ passive motion.

Mr. Aveling, of Sheffield, invented a very ingenious joint which allowed a foot piece to move in any direction, and ball-and-socket joints have also been employed. Other surgeons and mechanicians, especially in America, have invented various forms of apparatus for this deformity.

Mr. Adams's apparatus acts more directly upon the anterior part of the foot without pressing upon the side. It possesses three cog-wheel joints, one corresponding to the ankle joint, one to the transverse tarsal joint, and one to the joint between the tarsal and metatarsal bones. It has a thigh trough and a free joint at the knee. Its construction is shown in figs. 39 and 40.

Mr. Brodhurst adapted Langaard's modification of Scarpa's shoe for the following purposes :—

1. To rotate the scaphoid and anterior part of the foot inwards and downwards.
2. To extend and abduct the foot.
3. To flex the foot.
4. To act upon the entire foot.

FIG. 39.

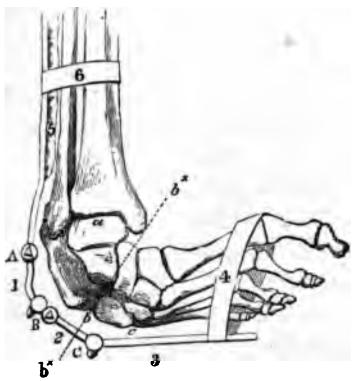


Diagram Illustrating the Construction of Mr. Adams's Apparatus for Adult Varus.

b*. Transverse tarsal joint. A. Joint corresponding to ankle joint. B. Joint corresponding to transverse tarsal joint, being a double joint, one for inversion and eversion, and the other for flexion and extension. C. Joint corresponding to tarso-metatarsal joints, allowing for inversion and eversion, to assist the joint B. 5. The point of resistance to the inverting force employed against the foot from the cog-wheels B and C.

Langaard's instrument consists of a laced boot with an outside lateral stem, a cog-wheel joint just below the external malleolus, &c., and two hinges above it. The stem by the side of the calf is fitted with a perpendicular screw, and the apparatus is laced to the leg and the thigh. The leverage is somewhat at a disadvantage with this apparatus.

If all deformity and ligamentous resistance be overcome in an infant or child, this treatment, Mr. Adams states, may only be necessary from six months to twelve months, the apparatus being worn during the day only.

If there is any symptom of relapse the shoe should be worn at night.

FIG. 40.

Mr. Adams's Instrument for Adult Varus.

1 1. Leg and thigh metal troughs with a free hinge joint for the knee. 2 2. Leather which folds over leg and thigh. 3. Heel piece connected to *a*, cog-wheel for ankle joint. 4. Oblique sole plate. *b*. Joint acting at right angles to *a*. *c*. Joint acting in the same plane as *a*, for uplifting the outer side of the foot. *d*. Joint acting in the same plane as *b*, used to increase the adaptation of the instrument to the curved form of the foot, and to assist the joint *b* in everting the anterior part of the foot. All these joints are cog-wheels.

Rubbing, shampooing, &c., passive exercises, and working the foot by flexion and extension, greatly assist in the cure. When a tendency to inversion of the foot occurs in consequence of weakness of the knee joint, a steel support must be extended up to the waist and attached to a pelvic belt; a free joint being placed at the knee.

Relapse.—Relapse has been attributed to a variety of causes, such as defects in the operative treatment (a *partial* division of tendons, for instance). But probably it is usually the result of relinquishing mechanical supports too early, under the mistaken idea that exercise, rubbing, sea bathing, &c., can do all that is necessary to complete the cure after operation.

Relapse is likely to take place if the case is abandoned before proper shape and normal range of action of the ankle joint is secured, or before the muscles have become normally strong, i.e. before equal power in opposing muscles has been attained.

Treatment of Acquired Talipes varus.

Cases of acquired talipes varus are to be treated upon the same general principles as the congenital; and they can usually be cured much more readily—that is, of course, if they do not depend upon permanent paralysis. If the extensors of the leg are paralysed, the support must be carried up to a pelvic belt, and constructed so that the knee joint may be fixed during progression, and be released for flexion when the patient sits down. When the paralysis only affects the muscles of the anterior part of the leg, the support may terminate in a strap below the knee. If necessary, an apparatus, with a cog-wheel joint at the ankle, must be worn at night, to prevent a return of the inversion.

Treatment of Congenital Talipes valgus.

Very slight cases, if treated directly after birth, may be cured by manipulations alone; if rather more severe, by bandaging to a splint or a valgus shoe. If severe, tendons may have to be divided. If the tendo Achillis is contracted, there should be two operations: the first to bring the foot into a straight line with the leg by division of the peronei, and perhaps the extensor longus digitorum; and the second to relieve the equinus which remains, by division of the tendo Achillis.

In dividing the *extensor longus* and *peroneus tertius* the puncture should be made in front of the ankle joint, where the tendons are usually prominent, and close to the inner border of the extensor longus tendon. When all the anterior tendons require division, this one puncture will suffice, as the knife can be made to divide the extensor pollicis and anterior tibial tendons from the same point.

For dividing the peroneus longus and brevis the knife is to be inserted between the edge of the fibula and the tendons, about half an inch above the external malleolus.

FIG. 41.

Posterior View of Valgus Boot for the Right Foot.

FIG. 42.

Inner Side-view of Valgus Boot.

The treatment after operation is to be conducted upon the principles already stated, and subsequently the boot now to be described should be worn.

Mechanical Treatment. — In slight cases, or after operation, a boot (figs. 41 and 42) should be used with an iron upright upon the outer side of the foot, the inner side being raised by a leather **T** strap attached to the sole of the boot, which buckles over the iron stem, upon the same principle as above described. If there is any contraction of the tendo Achillis, an instep strap should be added. Many other and more complicated apparatus are used. One consists of a well-padded leg-piece A, a side spring B, a movable pad C to support the arch of the foot below the scaphoid, a strap D to draw the anterior part of the foot towards the

FIG. 43.

spring; or, if there is also slight contraction of the tendo Achillis, or if that tendon has been operated upon, a modification of a Scarpa's shoe may be used, having the movable sole pad as just described, and an instep strap and ratchet joint opposite the ankle. By this boot the arch of the foot can be raised, and the whole foot can be flexed in opposition to the tendo Achillis.

In Langaard's shoe the movement of depression of the outer side of the foot is effected by a joint at the back of the heel.

FIG. 44.

FIG. 45.

In this form of talipes, as in others, it may be necessary to continue the apparatus to the thigh or pelvis. (See fig. 44.)

As described in reference to the other varieties of talipes, the foot is to be gradually brought into position by means of the cog-wheel joint, and subsequently a free joint is to be allowed at the ankle.

Passive exercise, &c., should be used, as in other cases of talipes.

In the subsequent treatment the heel of the boot may be carried obliquely forward on the inner side to support the arch (fig. 45), or a sole plate can be worn in the ordinary boot either for a long time or permanently.

Treatment of Acquired Talipes valgus.

The treatment must depend upon the origin of the deformity (see p. 46).

When there is muscular contraction, either from spasm or as a result of paralysis, the case must be treated upon the principles already laid down.

When the case is one of simple flat-foot, some support must be afforded the arch, and means adopted to strengthen the parts by cold-water bathing and stimulating liniments.

To support the arch of the foot one or other of the following plans may be employed :—

1. A steel arch fitted into the sole of the boot.
2. A removable sole plate.
3. Pads of guttapercha, &c.
4. The heel of the boot carried forwards on the inner side (see fig. 45).
5. A boot fitted with a light form of outside iron upright with a leather **T** strap, bearing from the inner side, as described at p. 74.

Horse exercise is better than walking, and a rocking-horse or propelling horse may be recommended for children.

If the debility has existed for long, the peronei and extensor longus digitorum may become contracted, and necessitate tenotomy and the subsequent treatment as already described under Congenital Talipes valgus.

In rachitic talipes valgus it is seldom necessary to divide tendons.

In paralytic talipes valgus the tendo Achillis often requires division, the peronei seldom.

Treatment of Talipes calcaneus.

Spastic Cases.—Very slight congenital cases may be cured by manipulation or bandaging to a splint.

If tenotomy is necessary, the *tendons requiring division* may be those of the following muscles :—

Tibialis anticus.
Extensor proprius pollicis.
Extensor longus digitorum.
Peroneus tertius.

The place of puncture for operation is in front of the ankle joint, close to the inner border of the tendon of the extensor longus digitorum. From this one puncture the knife can reach the tendons upon each side (as already remarked).

The *anterior tibial artery* is to be avoided.

The after treatment is to be conducted upon the principles already described. Mechanical support is not generally required for long after the operation. There is no tendency to relapse.

If the deformity arises from excessive length of the tendo Achillis, *the muscles of the calf remaining healthy*, the only means of radical cure is to remove a piece of the tendon and bring the ends into apposition for the purpose of their uniting and forming a shorter tendon. Several successful cases are recorded, but it cannot be considered a well-established operation, and the boot advised for paralytic cases usually answers all the required purposes.

Paralytic Cases.

If the deformity has existed for long the plantar fascia may require division, but it is very seldom that tenotomy is necessary.

Mechanical Apparatus.—A laced boot with a slight steel support upon one side, with a stop joint at the ankle to prevent flexion. Some retentive apparatus should be worn at night.

With regard to operating upon the contracted arch of the foot in paralytic cases, the surgeon should well consider whether such operation is desirable, because in some few cases the patient may be better off with the contraction than he would be if it were removed.

Talipes calcaneo-varus and calcaneo-valgus.

These varieties of club-foot do not require any special treatment differing from that of talipes calcaneus.

CHAPTER III.

ABNORMAL MUSCULAR CONTRACTIONS IN THE THIGHS AND ARMS.

In club-foot we have seen the results of abnormal contractions of the muscles of the leg, and we now proceed to discuss the subject of similar contractions as they affect the thighs and arms. With regard to *causes*, the reader is referred to the observations already made upon the origin of these contractions.

The thighs are sometimes flexed firmly upon the trunk, or the adductor muscles are fixed, so that the knees cannot be separated, or the legs may be contracted across one another; or, again, the legs may be flexed upon the thighs.

Such are the usual conditions when these deformities arise from spasmodic muscular contraction, but other positions may be assumed.

Figs. 46 and 47 are examples of congenital contraction.

Fig. 48 is an example of contraction, the result of acute rheumatism.

Fig. 49 represents a case recorded by Dr. Little,[1] the result of extensive inflammatory destruction of tissue, 'involving nearly the whole of the sacrum and nates and laterally exposing both trochanters.'

It is possible that this case may have been the result of inflammation in or around the joints, in which case it would, of course, be an example of ankylosis.

Treatment.—Cases of slight muscular contraction may be

[1] *Deformities*, 1853.

Fig. 47.

Fig. 46.

After Brodhurst.[1]

Fig. 48.

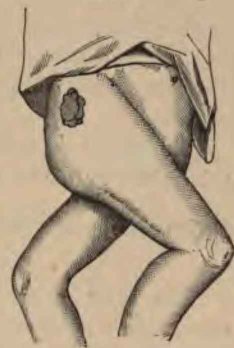
Contraction of Leg and Arm from Acute Rheumatism.
(After E. J. Chance.)

[1] *Orthopædic Surgery*, by Bernard Brodhurst. Lond. 1876.

treated by manipulations and exercises. If adduction of the thighs exist, the patient should practise walking with a board between the legs or thighs.

A very simple form of apparatus for separating the thighs is that recommended by Dr. Little; it consists of a short rod, the ends of which are attached to the thighs by bracelets. The rod can be lengthened by screw action.

FIG. 49.



Mr. Brodhurst advocates division of the contracted muscles when nerve irritation 'has entirely or in a great measure subsided.'

In performing tenotomy upon the adductor longus, the tendon is divided at about an inch from the origin of the muscle, the knife being entered from the outer side of the muscle and passed well beneath it, so that the division may be complete. Extension should be commenced about the third day after operation.

The adductor longus, the semimembranosus, the semitendinosus, and the biceps, one or all, may also require division.

The adductor longus can be divided at about one inch from its origin; the semimembranosus and semitendinosus near their insertion, care being taken to avoid the important vessels and nerves in their vicinity.

The biceps is divided as follows:—The patient should be placed in the prone position, and should endeavour to slightly bend the knee, which action will make the tendon tense. The tenotome is to be passed beneath the tendon from within outwards, between the tendon and the peroneal nerve, an inch above the insertion of the tendon. After the tenotomy the peroneal nerve becomes prominent and feels like the tendon, and so much so that the surgeon might imagine that he had not completed his operation.

Mr. Brodhurst's advice is good when he says that 'the knife should on no account be re-introduced;' for if care be taken in the operation, the tendon will 'certainly be divided' upon the first attempt.

For further information upon the subject of treatment see the general remarks upon club-foot.

Contractions of the Muscles of the Arms.

Treatment.—These contractions may usually be successfully treated by mechanical means, but occasionally the tendon of insertion of the *biceps*, or even of other muscles, may require division.

The after treatment should be carried out upon the same principles as after tenotomy for club-foot.

Deformities of the Hand from Abnormal Muscular Contractions of the Arms.

The hands may be deformed from contraction of their muscles in a manner analogous to the conditions met with in the various kinds of club-foot.

The general description of the nature of abnormal muscular contraction will be found in Chapter I.

In *congenital cases* the flexors and pronators of the hand are the muscles generally involved, so that the fingers and thumb are flexed, their tips directed towards the ulnar side of the forearm. The appearance is peculiar and characteristic. This condition has been considered analogous to talipes varus, the flexors of the hand being considered to occupy the place of the extensors of the foot.

Anatomically this view is probably correct; and, as mentioned by Dr. Little, the fact is well exemplified in the extremities of the quadrumana.

Treatment.—If these cases be treated early in life the deformity may be usually very considerably improved or completely cured by bandaging the hand in a normal position to small metal splints in a similar manner to the process described for the treatment of club-foot in infants. In some few cases, and more often in *acquired club-hand*, the tendons may require divison, but this operation should be avoided if possible.

The delicate and accurate movements of the hand and fingers require the most perfect condition of the action of the muscles; and although tenotomy is not necessarily followed by the loss of any degree of this accuracy, yet such a result may occur; and it will readily be understood that a slight impairment of function, which would not be noticed, or be of no detriment in the muscles of the feet, would in the muscles of the hand be a matter of considerable importance. Therefore it is very desirable to avoid tenotomy in hand contractions, if possible.

The muscles that may require division are

The flexor carpi ulnaris,

'Pronator radii teres,' and

'Palmaris longus,'

and occasionally

The flexor longus pollicis and

Flexor sublimis digitorum.

Contractions have been met with in other muscles; and the hand may be supinated or extended, or may occupy an intermediate position.

When the hand is supinated, the deformity is considered to be analogous to talipes valgus.

Manipulations, frictions, exercises, the use of various apparatus for extension are valuable remedies in the majority of instances. All these cases require great care and attention, the result of which is, however, usually satisfactory; and, if a cure cannot be made, considerable improvement may always be effected.

The reader is referred to the remarks upon the nature of abnormal muscular contractions for the pathology of hand contraction, and to the article upon deformities of the digits for further details regarding treatment.

CHAPTER IV.

DEFORMITIES OF THE DIGITS (FINGERS AND TOES).

Congenital.
- Hypertrophy.
- Deficiency.
- Supernumerary digits.
- Union of digits.
- Contractions.

Acquired.
- Deformities from nerve lesions.
- Writer's cramp.
- Contractions.
- Deformities the result of badly shaped boots.
- Hammer toes.

1. *Congenital Hypertrophy.*

When this disease exists, the affected digit is larger than its fellows at birth in consequence of an increased development of all its normal tissues, or of fat alone.[1] One or more digits or joint ends may be affected, or the hypertrophy may extend to the hand or foot, or the whole limb may be involved.

Treatment.—If the deformity occurs in the feet, and there is an increase in length, the sound limb must be raised by a thick sole to the level of the enlarged one. Well-regulated pressure has been successful in reducing the enlargement to a considerable extent. Amputation has been often performed for hypertrophy, and some writers recommend it as the only remedy. Mr. Holmes, however, advises a more

[1] Curling, *Med. Chir. Trans.* vol. xxviii.

conservative treatment, and, as congenital tumours sometimes disappear spontaneously, he supposes that hypertrophied digits or limbs might do so as well, but each case must be dealt with according to circumstances. It has been suggested that the main artery of the limb should be tied, or *liquor potassæ* given internally.

2. *Congenital Deficiencies.*

There may be deficiency in number or of bulk.

Treatment.—Usually no treatment is applicable, but occasionally adhesions between the remaining or diminutive digits may exist, in which case some relief may be given; or contracted fasciæ may require division; or when a minute digit is useless, and an obstruction to the movement of the others, it may be amputated.

3. *Supernumerary Fingers and Toes* (*Polydactylism*)

May occur as—

a. A rudimentary digit *attached* loosely and by a pedicle to any part of the hand, foot, or other digits.

b. A fully formed digit *articulating* with an articular extremity, or with the surface of one of the other digits, or parts of the foot or hand.

c. A digit intimately united to the whole length of another digit, having either a separate metacarpal or metatarsal bone, or articulating in conjunction with its neighbour.

If a supernumerary digit articulates in conjunction with its neighbour upon one metatarsal bone, there usually exists but one capsular ligament, and the cavity of the joint is common to both digits.

Treatment.—The only remedy is amputation, but this should not be performed until it is determined that such a course is the best for the patient. A supernumerary digit may happen to be a very useful member. If the extra digit joins the hand or foot in conjunction with one of the other digits, their articulations will, as just stated, probably communicate, in which case it has generally been recommended that amputation should not be performed at the joint, but at a short distance away, so as to leave the joint intact.

4. *Congenital Union of Digits.*

The junction may be by soft parts only, or by fusion of the bones, and in either case the union may be more or less complete.

The junction may be by loose folds of skin (webbed fingers or toes).

Treatment.—It is not generally necessary to operate upon the toes for this condition. With regard to the fingers the case is different, and if there be a longitudinal junction by *soft parts* division may be easily made between the bones, and the respective edges united by sutures, but the tendency to reunion is so strong that some special means must be adopted to prevent it.

Method of M. Didot, of Liège.—The flap is made for one digit from half the dorsal surface of its neighbour, and the flap for the second from half the palmar surface of the first digit. This operation will be understood from the following illustrations. By this manner of operating the unions of the wounds will be separate from one another. Annandale proposes that smaller flaps should be made, for the purpose of not encroaching so much upon the dorsal and palmar surfaces. In either case the wounds must be very carefully attended to, in order to prevent reunion or contraction. Reunion, when it occurs, always commences at the cleft.

Division of the Union after making a Permanent Opening at the Base of the Web.—Several means have been devised for making this opening.

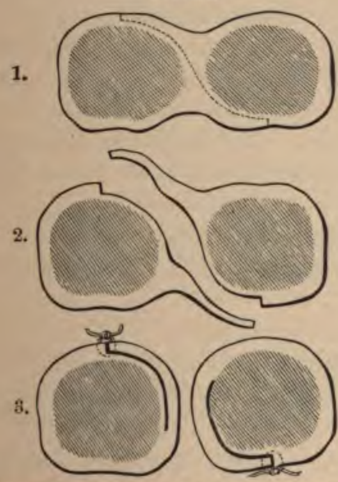
1. A fine silver rod, having a flat head at one end and a screw at the other, is passed through the base of the web, and a nut is then screwed on to it, so as to retain the rod in position, and this simple apparatus is allowed to remain in place until cicatrisation has commenced.

2. Another plan is to pass an indiarubber cord through the base of the web by means of a trocar and canula, and attach it to a band at the wrist. The advantage of this plan is that the

FIG. 50.

Didot's Method of Operating for United Fingers (after Fort).

FIG. 51.



Diagrams of Transverse Section of the Fingers operated on by Didot's Method. 1. Showing the line of incision. 2. Showing the separation of the fingers. 3. Showing the flaps adjusted. (After Fort.)

FIG. 52.

FIG. 53.

(After Fort.)

cord, being soft and elastic, allows free movement of the hand, or the division may be made at once and the elastic cord then attached (fig. 53).

Norton's Method.—Mr. A. T. Norton has described [1] a plan of cutting little flaps from the fingers, which after division of the junction may be made to bridge over the bottom of the cleft, and so prevent reunion of the fingers at this important point. Other means have been employed, but the above-mentioned are the simplest. When *the bones are united* an operation is seldom desirable.

5. *Congenital Contractions and Consequent Displacements of Fingers and Toes.*

These deformities may depend upon bands of fascia or upon contracted muscles. The principles of treatment as described under Club-foot may be applied to these cases. Careful bandaging to suitable splints will generally be quite as efficacious as the employment of the elaborate and expensive instruments usually recommended by mechanicians.

FIG. 54.

(After Annandale.)

Deformities may be caused by *exostoses, &c., of the articular extremities* of the bones. They must be treated upon general surgical principles.

Deformities of the Digits from Nerve Lesions.

Paralysis or spasmodic contraction of the muscles may be caused by—

1. Disease or injury of the nerve centres.
2. Disease or injury of a nerve in any part of its course.

Among the causes of injury to a nerve in its course may be mentioned

Forcible attempts to lift up a person by the arm (Annandale).

[1] At the annual meeting of the British Medical Association at Ryde August 1881.

Bands or bracelets placed tightly round the arm or wrist (Paget).

Retention of an arm in a constrained position during sleep, such as resting it over the back of a chair.

The use of crutches.

Foreign bodies embedded in wounds near a large nerve.

Implication of a nerve in a cicatrix.

Motion is generally more impaired than sensation.

Paralysis may be immediate or come on gradually. (See Chapter I., 'Abnormal Muscular Contractions.')

Excessive use of the hands may cause paralysis, as we find in scriveners', sempstresses', shoemakers', and musicians' palsy or cramp.

In all these cases the only muscles which are affected are those which are overworked. Clonic spasms usually, but not always, precede paralysis in these cases. Paralysis from lead-poisoning is frequently met with.

Treatment.—For the immediate treatment of injured nerves the reader is referred to works upon general surgery.

Treatment of Deformities following Nerve Lesions.—The possibility should be recognised of a foreign body—a piece of glass, for instance—remaining in the neighbourhood of a nerve for months or years after an injury, and if such a condition is found to exist the foreign body should be cut down upon and removed.

If paralysis exists in consequence of division of a nerve, the parts may be cut down upon, and the divided ends brought together by a suture, an operation which has proved successful even when performed several months after the original injury. If the paralysis is incurable, the treatment must be directed to supplying mechanical means to compensate for the loss of motion. (See Inmann in 'Med. Chir. Trans.' vol. i.)

Writer's Cramp, or Scrivener's Palsy.

This affection consists in spasmodic action of certain muscles of the hand, used in some special and complicated action, such as writing, sewing or playing the piano. The pathology is obscure, but the affection has been considered to resemble closely spasmodic wry-neck.

The spasmodic and uncontrollable actions only occur when the hand is used for the one particular kind of action, and it has been thought by some observers that over-work of the muscles is the cause of their irregular contractions.

Cases have occurred, however, in which over-work could not have been the cause.

For further information upon the nature of this disease the reader is referred to the papers named below.[1]

Treatment.—A great variety of medicinal remedies, and also local applications, have been tried and found to fail in giving relief.

Dr. Althus speaks favourably of galvanism of the cervical sympathetic nerve; but Dr. Reynolds has tried 'galvanism and electricity in all its forms,' and has seen no good result.

Absolute rest is the only treatment that has effected much good, and when adopted early in the case, a cure may result. Stromeyer seems to have cured a case by dividing the *flexor longus pollicis*; and the result was probably the effect of enforced rest. Diffenbach performed the same operation without success.

Apparatuses to enable the patient to write by using other muscles of the hand or arm are often recommended by mechanicians; but they are dangerous remedies, because they only ward off the disease for a short time, and that short time would have been valuably employed in giving entire rest to the affected member.

A new plan of treatment is now being tried in Paris, and is reported to have cured some obstinate cases. It consists of active exercise of all the muscles of the hand and violent passive movements and friction of the affected muscles.[2]

[1] Solly, on *Scrivener's Palsy*, *Lancet*, January 20, 1865; Russell Reynolds, *System of Medicine*, vol. ii.; Althus on *Scrivener's Palsy* Pamphlet, 1870.

[2] See *Brit. Med. Jour.* January 28, 1882.

Treatment of Paralysis of the Extensors.

If the paralysis is the result of lead-poisoning, the hand should be supported on a splint during the elimination of the lead from the tissues of the patient by purgatives and iodide of potassium.

Subsequently exercise of the muscles by passive and, if possible, by active movements, or by electricity, will be beneficial. Dr. Taylor[1] employed 'faradisation' with apparently good effects, the muscles being more useful after its employment, although the electricity did not cause the muscles to act under its stimulation.

The elastic supports to be now described will often be useful in the treatment of lead paralysis.

Permanent Paralysis of Extensors.

If the extensors are permanently paralysed, from whatever cause, some elastic apparatus to take their place must be employed. The elaborately constructed instrument of M. Rigal, or that of MM. Robert and Collin, made under the direction of M. Duchenne, may be used; but in many cases a more simple apparatus will answer the purpose. Dr. Taylor, in the paper already referred to, describes a very practical plan of supplying the necessary support. A piece of common flat elastic band is sewn to the back of a leather glove and attached to a strap encircling the elbow.

Acquired Contraction of the Fasciæ of the Digits.

Causes.—Inflammatory changes, which may be traumatic (including burn cicatrices), or rheumatic, or gouty. The contraction may, and often does, come on gradually, independently of inflammation.

The palmar fasciæ are peculiarly liable to induration and contraction. This is commonly called *Dupuytren's contraction*, and consists in a peculiar affection of the palmar fascia alone, the tendons and all the other structures remaining perfectly

[1] *Medical Times and Gazette*, August 11, 1860.

normal. Goyrand, however, according to Adams, considered the contracted bands are abnormal fibrous fasciculi, distinct from the palmar fascia.

The fingers may thus become bound down to the palms of the hand, or the toes to the sole of the foot; the tendons may become subsequently shortened from adapted contraction. Dupuytren's contraction usually occurs at about middle age.

This affection is often associated with a gouty or rheumatic diathesis. It has been sometimes apparently brought on by

FIG. 55.

From Mr. Partridge's specimen in the Royal College of Surgeons Museum, No. 1444. (Reversed from Druitt's 'Surgeon's Vade Mecum,' which shows the wrong hand.)

pressure and friction, but, as it has often occurred in individuals whose hands have not been subjected to much pressure or friction, such exciting cause is not the invariable one. The thumb and index finger are seldom much contracted.

The following illustration was made for Mr. Adams from a drawing by Mr. Goodart of a preparation in St. Bartholomew's Hospital Museum.

The tendons, being bound down by the sheath, are far removed from the position of the contracted band of fascia. (The digital prolongations of the palmar fascia are always attached to the periosteum of the proximal phalanx.)

Fig. 56.

Dissection of finger contraction, affecting the middle and ring fingers, showing that the contraction depended upon the palmar fascia alone.
a. Contracted band of palmar fascia stretching across like the string of a bow. *b.* Flexor tendons lying deeply, passing through *c.* Sheath of tendons. *d.* Digital prolongations of palmar fascia. (After W. Adams.)

Treatment of Dupuytren's Contraction.—Slight cases may be cured by gradual mechanical extension, kept up constantly, day and night; but this mode of treatment is very tedious, often painful, and seldom effective.

Division of the contracted fascia is the most effectual remedy. The operation should always be subcutaneous. Mr. Adams recommends '*multiple subcutaneous divisions of the fascia and its digital prolongations*' with a very small knife, which is passed between the skin and the contracted band of fascia. The fascia is then divided inwards carefully. The *first* division may be made in the palm, between the transverse crease and the annular ligament, just free from the part where the fascia is united to the skin; the *second* division in the palm, close to the fingers; the *third* and *fourth* divisions are to be of the digital prolongations of the fascia, care being taken to avoid injuring the digital vessels and nerves. Central incisions opposite the first and second phalanges should be avoided, for fear of injuring the sheath of the tendon.

Fig. 57.

There may be other bands of fascia requiring division. The wound should be treated as after *tenotomy*, and the affected finger *immediately extended* as much as possible, and bandaged to a splint. If the finger cannot be placed quite straight at the time of operation, it should be stretched to that position as rapidly as possible. The finger or fingers must be retained in a straight position, day and night, for at least three weeks, and after this time the splint must be worn at night for another month or longer.[1]

The mode of operating upon the plantar fascia is described under Club-foot (p. 61). The fascia should be divided where its tension is most marked. If a tendon has to be divided

FIG. 58.

Dissection of the Tendons of the Finger (after Dr. J. A. Fort[2]).

a. Filament attaching the deep flexor tendon to the phalanx. *b.* Tendon of deep flexor muscle. *c.* Fold extending from the deep wall of the sheath to the superficial tendon. *d.* Tendon of superficial flexor muscle. *e.* Tendon of deep flexor muscle. *f.* Slip from deep tendon. *g.* Sheath of tendons reflected.

also, the two operations should be performed at different points, so as to avoid the risk of adhesion of the tendon to the fascia.

Rigidity of the phalangeal and metatarso-phalangeal or metacarpo-phalangeal articulations may occur after rheumatic, gouty, or other inflammation. There is usually a tendency to

[1] *Contraction of the Fingers*, by W. Adams.
[2] *Des Difformités des Doigts*. Paris, 1869.

contraction of the flexor muscles, and when occurring in the foot, a claw-like contraction of the digits may be present.

Treatment.—The general health may require treatment.

Locally, when any active disease is present, steam baths or alkaline baths, with gentle manipulations, should be employed, and emollient or moist applications. A splint must be used to prevent further contraction.

When active disease has ceased, if the case is slight, manipulations alone may effect a cure, but some form of splint is generally necessary to keep up the good effect gained after each extension.

These means should be perseveringly tried for a long time before any operative treatment is resorted to; but, if necessary, tenotomy of the *flexors* must be performed, and in some few cases the cure cannot be accomplished until the *extensors* also are divided.

Tenotomy of the Deep and Superficial Flexors of the Fingers.

It would be very difficult to divide either set separately in their normal condition; but one being abnormally tight, the operation becomes easier.

The deep flexor should be divided at a point corresponding to the union of the distal 4th with the proximal $\frac{3}{4}$th of the phalanges. By selecting this spot the divided ends are not separated very far from one another, because the proximal end is held in position by the synovial fold.

If both flexors are contracted we should begin by dividing one or two of the tendons of the deep flexor at 4 millimeters (about $\frac{1}{6}$ of an inch) in front of the articular fold which separates the palmar surface of the distal from the second phalanx. It is best to divide two tendons not of adjoining fingers, and then the others. Section of the superficial flexor should then be made opposite the distal fold of the palm of the hand.

After the operation the hand and forearm are to be fixed in an immovable apparatus for five or six days, and then extension must be made very gradually.

Contractions and distortions of the digits may be the result of tumour or other forms of pressure, or of injuries, bruises, fractures, and dislocations of the bones of the forearm, hand, or fingers.

Tendons may become adherent to surrounding parts.

DEFORMITIES OF THE FEET FROM THE USE OF BADLY-SHAPED BOOTS.

The various deformities of the feet from this cause result from boots which are either

Too short,

Too tight, or which have

The anterior extremities contracted,

The heels high and displaced forwards,

The anterior extremities formed so that the great toes are bent outwards.

The metatarsal joint of the great toe is very often affected by the last-named formation of boot. The joint is subjected to pressure, and the internal lateral ligament is stretched. The bursæ, and subsequently the whole joint, become inflamed.

Treatment.—It is absolutely necessary that the patient should procure boots which are constructed upon the following principles:—

1. Sufficiently large to allow free movement of the foot.
2. To allow the space of $\frac{1}{2}$ or $\frac{3}{4}$ inch beyond the toes.
3. To allow space for the great toe to be in a straight line with its metatarsal bone.
4. To possess a heel of about $\frac{1}{2}$ inch to $\frac{5}{8}$ inch thick, and not narrower than the heel of the foot.

If active inflammation of any of the joints be present, rest, cooling lotions, or the application of solution of nitrate of silver (ʒj to ℥j) must be employed.

When the boots have been procured, means may be taken to bring the great toe into its normal position. The following illustration shows a mode of effecting this object.

FIG. 59.

(After Sayre.)

Hammer Toes.

The contraction of the toes in a flexed position also generally arises from wearing short boots, but occasionally the deformity seems to occur independently of this cause, and is often the result of contraction of the digital fascia, as described above.[1]

[1] See Nunn, *Trans. Clin. Soc.* vol. xi. p. 153.

CHAPTER V.

WRY-NECK.

Synonyms—Latin, *Torticollis*; French, *Torticolis*; German, *Halssteifheit*; Italian, *Torcicollo*; Spanish, *Torticolis*.

THIS deformity may be—

1. Congenital, or
2. Acquired.

Congenital Wry-neck.

Causes.—Abnormal muscular contraction.

The contracted muscles resemble those involved in congenital club-foot, and both deformities are the result probably of similar causes.

The sterno-mastoid muscle of one side is usually the chief or the only muscle affected; but the trapezius, the scaleni, and possibly other deeper muscles are also often involved.

The head is approximated to the shoulder, and the shoulder is generally drawn up somewhat above the level of that of the opposite side. The chin is drawn away from the contracted side.

Sterno-mastoid.—The contraction of this muscle may be limited to one or other of its insertions, or may involve both.

One insertion only may appear tense, but when that is divided it will often be found that the other head shows shortening, tenotomy of that portion also being required.

The features of the affected side are distorted by being drawn downwards, and they may be less developed than upon the opposite side of the face.

Results.—1. If no treatment is adopted, the contraction increases steadily but surely.

2. The clavicle is sometimes bent upwards by the traction of the muscle.

3. The cervical vertebræ curve in the opposite direction, and a compensatory curve is formed lower down the spine.

4. The eyes being placed upon a different level, vision becomes imperfect.[1]

Treatment.—If the affection is very slight, the surgeon may try the effects of extension; but spasmodic contraction of the *sterno-mastoid* resembles the same contraction in the muscles influencing the *tendo Achillis*, in that tenotomy is generally, if not always, required to effect a cure. The methods of employing extension are described below in reference to 'acquired wry-neck.'

Division of the Sterno-cleido-mastoid Muscle.—One or both origins may have to be cut. The patient should lie upon his back, and the neck should be stretched over a pillow so as to make the muscle tense. The place at which the tendon is most prominent is usually recommended to be selected for the operation, and this is about $\frac{1}{2}$ or 1 inch above the clavicle. Mr. Adams, however, prefers to divide the tendons as close to their attachment as possible.

If both origins are tense, each should be divided through a separate puncture.

If the muscle is not very prominent, it should be lifted forwards by the finger and thumb.

The puncture should be made with a sharp-pointed and the operation completed with a blunt-pointed tenotome.

The latter is to be passed as close as possible to the tendon. It is sometimes necessary to divide also some bands of fascia.

As in all tenotomy operations, the finger should be pressed upon the track of the puncture as the knife is withdrawn, so as

[1] See Little, *Trans. Obst. Soc.* 1862.

to prevent the entrance of air into the wound. A compress of lint is to be attached with plaster and a simple bandage applied.

The head may be fixed in a position as near the normal as the divided muscle will allow, without force being employed (Little).

To Fix the Head.—The following plan for fixing the head for making extension upon the parts is recommended by Dr. Little.

With adhesive plaster and calico bandage, a band is formed round the head encircling the forehead and occiput, and one round the waist. A ribbon is to be sewn to the head bandage just above the ear of the unaffected side, and carried down diagonally in the direction of the normal sterno-mastoid muscle to the waist bandage, and there fixed. This plan produces flexion of the head, a position which can be prevented by the use of an additional band reaching vertically from the back of the head to the waist-band.

An apparatus such as that recommended for acquired wry-neck may be used.

After four or five days' rest, manipulative extension may be commenced and continued daily for several weeks, and the treatment will take from a month to three months, or longer.

When the head is restored to its normal position, attention should be given to the spine, which may possibly have become curved and require treatment. The spinal muscles and ligaments are often weak in these cases.

Acquired Wry-neck.

Causes.—This affection may arise from—

1 Spasm.
2. Rheumatism.
3. Paralysis.
4. Long-continued position.
5. Caries of the cervical vertebræ.
6. Hysteria.
7. Traumatic injuries.

1. *Spasmodic Contraction of the Sterno-mastoid and Trapezius and other Muscles.*

The sterno-cleido-mastoid is the muscle chiefly or solely affected.

The *origin* of the contraction is obscure, and is probably irritation existing in the course of the spinal accessory nerve. This may occur from traumatic or from many other nerve lesions, or it may be a reflex action. See Chapter I. Other symptoms of nervous disorders may be present. The character of the spasms is similar to that of chorea; but, unlike chorea, spasmodic wry-neck is a disease of adult life, usually commencing about the age of 30, or later in life, and in women at the climacteric period.

Treatment.—The bodily health usually presents indications for general treatment. Tonics and remedies which act in one way or other upon the nervous system have been frequently tried in these cases, but seldom with much effect. Dr. Little states[1] that he cured two cases with bromide of potassium; and cases have recovered after the administration of mercury. Purgatives have also been apparently successful. Local emollients—lin. Aconiti or ung. Veratrii (the latter double or three times the Pharmacopœial strength)—might be used to the upper part of the neck, in the region of the spinal accessory nerve.

Tenotomy, or *myotomy*, of the affected muscles relieves the spasm at once; but the affection may return directly reunion takes place. It might be desirable to redivide the muscles in a severe case. Stromeyer (according to Bauer) cured a case after dividing both origins of the sterno-mastoid, and subsequently the clavicular attachment of the trapezius. Bauer failing to relieve a case by division of the platysma and the sterno-mastoid, dissected down carefully upon the anterior scalenus and divided it upon a director. The patient was materially relieved. The danger of injuring the phrenic nerve and other important nerves or vessels would probably deter all cautious

[1] Holmes's *Syst. of Surgery*.

surgeons from performing such an operation as described by Bauer. The operation of stretching the spinal accessory nerve has been tried and has failed. This operation might be productive of harm, in consequence of the connection between the spinal accessory and other important nerves.

Division of the External Branch of the Spinal Accessory Nerve will relieve the spasms. This relief may be permanent or temporary. If it is necessary to repeat the operation it may be desirable to remove a piece of the nerve, as done by Mr. C. de Morgan,[1] who almost completely cured a very bad case. Mr. John Wood[2] has also performed this operation, curing one case and relieving another. Mr. Annandale[3] cured a case by excision of part of the nerve after stretching of the nerve had failed. Dr. Ogle administered valerianate of zinc, and used subcutaneous injection of morphia with and without atrophine, which 'frequently but not always' mitigated the spasm.[4] Cannabis Indica internally and injection of arsenic failed in Dr. Althus'[5] hands, as did the constant galvanic current. Busch tried the application of the actual cautery in four cases, three of which are reported to have been cured.

2. *Rheumatic Wry-neck.*

The deep-seated muscles are usually involved, and it is often difficult to determine the exact seat of the affection.

Treatment.—The general health must be treated, and an instrument adapted by means of which the head can be gradually brought into a normal position. The instruments which have hitherto been described, fail in completely controlling the movements of the head, and some of them are also very heavy.

Apparatus.—The instrument should be constructed upon the following plan (as employed at the City Orthopædic Hospital):—

[1] *Brit. and Foreign Med. Chir. Rev.* July 1866.

[2] See Dr. Ogle's paper, *Clin. Soc. Trans.* vol. vi.

[3] *London Med. Record*, vol. viii. p. 228.

[4] Dr. Ogle refers to Dr. da Costa's experiments of the injection of atrophine in wry-neck. *Pennsylvania Hosp. Repts.* 1868.

[5] *Clin. Soc. Trans.* vol. xii.

A light pelvic belt with two upright bars and shoulder-straps forms the basis of support; from this framework an upright bar reaches as high as the occiput, and from the extremity arms proceed forwards to grasp the head. Joints are provided opposite the occiput, and also opposite the last cervical vertebra, which can be moved in any direction either by rack joints or by fixable ball and socket joints.

3. *Paralytic Wry-neck.*

The healthy muscles contract upon the sound side, in consequence of absence of power in the antagonist muscles. In the course of time permanent shortening of the contracted muscle or muscles takes place.

Causes.—Partial paralysis or weakness of the muscles of one side of the head may occur at birth. This condition is considered by some as congenital, by others as the result of injury during delivery. Infantile paralysis or various other nerve lesions may cause this variety of the deformity.

Treatment.—If at birth the sterno-mastoid of one side is deficient in power, means should be taken to give the muscle rest, and to stimulate its nutrition by warmth and friction. The general health should also be attended to. If the recovery is tardy, hot water fomentations and stimulating liniments may be employed. Possible sources of reflex irritation should be inquired into. If the muscles are permanently paralysed, the only suitable treatment is support of the neck by a padded leather or steel spring cravat or other supporting apparatus. If there is permanent contraction of the sterno-mastoid, which cannot be overcome by mechanical means, tenotomy or myotomy is necessary.

4. *Wry-neck from Position*

May occur, especially in children, from disease of the cervical glands and other painful affections.

Treatment.—The cause must be dealt with first, and the head supported in the most comfortable position. Any contraction that results must be treated upon the principles already stated.

5. *Wry-neck from Disease of Vertebræ.*

See 'Caries of Spine,' Chapter XI.

6. *Hysterical Wry-neck.*

This variety is often a very troublesome one. No exact rules of treatment can be laid down.

7. *Traumatic Wry-neck.*

Several cases of wry-neck the consequences of injuries to the muscles and nerves are recorded in the 'History of the American War of the Rebellion.'

CHAPTER VI.

CONGENITAL DISLOCATIONS—DISPLACEMENT OF THE SEMILUNAR FIBRO-CARTILAGES OF THE KNEE JOINT.

Congenital Dislocations.

Congenital luxations or sub-luxations may be found in the hip, knee, wrist, shoulder, elbow or jaw, but those of the hip are the most frequent. These displacements or malpositions usually depend upon deformities, chiefly deficiencies, of the articular ends of the bones, but they have been attributed to other cause, such as disease of the joint (gouty or syphilitic synovistis, for instance)[1]; paralysis, or contraction of muscles, or a combination of both conditions; also injury during delivery, in which case the joint may have been normal.

Hip Joint.

Dislocation of this joint is usually on to the dorsum ilii. In monsters it may be in other directions. It usually occurs upon both sides, and is more frequent in females than in males. Mr. Howard Marsh[2] has described fourteen cases, of which the following are the most noteworthy points :—

Case I. A preparation in the Hospital Museum, with no history, but the acetabulum is filled with fibrous tissue, and there is no *ligamentum teres*. The head of the femur is small and conical.

[1] A view originated by Ambrose Paré, and supported by Lédillat, Malgaigne, Gerdy, Paraise and others. (Brodhurst.)

[2] *Bartholomew's Hospital Reports*, 1875.

Case II. A girl, aged nine, who walked with the 'rolling gait' peculiar to this affection, but the femora did not slide upon the pelvis, as is often the case.

Case IV. A woman, aged thirty-six. The head and neck of both femora seemed to be 'in great part or wholly absent.'

Case V. Daughter of Case IV.

Case XI. The upper end of the femur was 'stump-like' and fixed by a false joint to the pelvis.

And the others were somewhat similar cases.

Symptoms.—This displacement often passes unobserved at birth. There is no pain, the direction of the limb is not materially altered, and 'the motion of the head of the bone is free.' By rotating the limb the head of the bone may be felt. If the dislocation is double 'the pelvis becomes very oblique,' 'the pubes being carried backwards, and the sacrum raised,'[1] lordosis occurs. There is a tendency to adduction of the thighs, 'constituting in some cases genu valgum.' The gait is peculiar —a rolling motion of the trunk with double lameness. If the dislocation occurs upon one side only, the limb is shortened.

Treatment.—If treatment is adopted early—before much accommodative change has taken place in the joint—the results will in some cases be satisfactory. If much muscular contraction has taken place, some of the muscles may have to be divided before the head of the femur can be retained in the acetabulum. Mr. Holmes[2] refers to a case treated by M. Pravaz, jun., by extension for six months, and then reduction, and the employment of a retentive apparatus. After several months of the above treatment, passive and then active motion was practised in the horizontal position. The case was cured at the end of two years.

An apparatus somewhat similar in principle to that recommended for hip-joint disease should be employed, with modifications according to the particular circumstances of the case.

[1] Brodhurst, in *Holmes's System of Surgery*, vol. v.
[2] *Surgical Treatment of the Diseases of Children*, 2nd edit. 1869.

Congenital Dislocation of the Knee Joint.

The deformities which are commonly thus designated may consist in partial dislocation, but they more often consist in a condition of hyper-extension and a decreased range of flexion. The latter condition has been attributed to the shortness of the quadriceps femoris muscle, but in a case lately examined by the author the inability to flex the leg seemed to depend upon some abnormal condition of the joint. The patella is said to be often absent, but Dr. Little states that this idea is erroneous, and in the case just referred to the author discovered the patella after some slight difficulty.

Treatment.—While the child remains very young the treatment should be confined to manipulative flexions of the leg, but subsequently an apparatus should be provided to restrain hyper-extension while flexion is permitted. As the exact conditions of the joint vary in different cases, the treatment must be modified accordingly.

Congenital Dislocation of the Upper Extremity

Is comparatively rare. Luxation of the shoulder Dr. Little supposes to be the result of infantile paralysis. Abnormal flexion of the elbow and various contractions of the hand may exist.

Displacement of the Semilunar Fibro-cartilages of the Knee Joint.

Judging from the symptoms, these cartilages are liable to displacement in various directions. In a case recently dissected by Mr. Godlee,[1] the external cartilage occupied a vertical position in the intercondyloid notch. But this is probably an exceptional case. Usually, the displacement seems to be very slight.

Causes.—1. The foot being suddenly arrested unexpectedly during progression; 2, or twisted when the joint is in a lax

[1] *Transactions of the Pathological Society*, vol. xxxi. p. 240.

and passive condition, and the leg is slightly flexed upon the thigh; 3, or it may possibly arise from other sudden movements of the joints.

Symptoms.—Sudden pain at one or other part of the joint, generally referred to some part of the circumference. The pain is peculiar in its nature. It does not usually occur unless the patient attempts to walk, and then it often assumes more of a disagreeable feeling of discomfort and stiffness of the joint than of acute pain. The joint, usually, can be freely moved by the surgeon up to a certain point, and without causing pain; but there is a mechanical impediment to complete extension. Sometimes the range of motion is very slight; at others no impediment to complete extension exists. The general appearance of the joint is either natural, or there may be a slight bulging in one or other place, or more or less effusion in or around the joint.

Diagnosis.—This displacement may be mistaken for a sprain; with which, in fact, it may be associated. In the latter case, when the swelling and general symptoms of the sprain have passed off, the inability to walk soundly remains. The pain of a sprain is more diffused, and it is generally accompanied with heat and tumefaction. When a cartilage is displaced inability to extend the leg completely is usually a prominent symptom.

Treatment.—Mr. Hay, of Leeds, who was the first to describe this affection (about 1790), placed his patients upon an elevated seat, with room to flex the leg thoroughly upon the thigh. He then placed one hand upon the patient's knee, and with the other hand extended the leg gradually. He then 'suddenly moved the leg backwards, that it might make as acute an angle with the thigh as possible.' In some cases, gradual flexion and then sudden extension may be successful; but one or other of these manipulations, alone or combined with rotation of the leg, have always succeeded in relieving the patient in the author's hands. In cases that have existed for several years, it may sometimes be necessary to thoroughly relax the tissues by fomentations and poultices before the reduction of the displaced cartilage can be effected. The after treatment consists in passive movements of the joint every few days for a time; the frequency and duration of the treatment being regulated by the condition of the joint. When the displacement has existed for a long time (perhaps several years), passive movements must be continued for several weeks at least. The joint should also be rubbed once or twice a day with a stimulating liniment. In bad cases, when the ligaments of the joints are lax or weak, a light lateral support is necessary (fig. 60), allowing free flexion and extension, but preventing lateral motion, and movement of the tibia forwards upon the femur, except during extension. This apparatus is very comfortable to the patient; affords all the necessary protection without interfering with flexion and extension. It is light, and can be easily put on and taken off. Ordinary knee-caps have qualities which are the contrary of the above; and cannot, therefore, be recommended.

FIG. 60.

CHAPTER VII.

CONTRACTED AND DEPRESSED CICATRICES.

CONTRACTED CICATRICES are the result of burns and other injuries or inflammatory affections which have destroyed the true skin, and perhaps some deeper structures. The theory that epithelium is only developed by epithelium is probably correct; and if the skin be so far destroyed that the rete Malphigii is involved, the wound can only heal by fibrous cicatricial material. This material gradually contracts, so that important structures are involved. *Ectropion*, for instance, may be produced, or joints may be contracted. The following figures show cases of these deformities :—

In some subjects, especially in the young, the bones may become bent by such contractions. The contraction may continue to increase for an indefinite period.[1]

Treatment : First Treatment of the Wound.—Attempts are often made to enlarge the cicatrix that is forming by keeping the involved parts stretched as much as possible.[2] But such a means of treatment must be adopted with extreme caution; as if thereby the cicatrix be retarded in healing, the contraction will ultimately be more severe. Therefore, the parts should be

[1] The fact must here be referred to of the growth of cicatrices in accordance with the growth of the part upon which they are situated. See Sir J. Paget's *Surgical Lectures*; and Mr. Adams, *Path. Soc. Trans* vol. xi.

[2] Holmes's *Surgical Treatment of the Diseases of Children*, p. 270, 2nd edition.

extended as much as is possible without interfering with the healing of the wound; but directly cicatrisation is complete,

FIG. 61.

Drawing from a cast of the foot of a lad who had been burnt. One toe was destroyed. (After E. J. Chance.)

FIG. 62.

Outline drawing from the cast of a person severely burnt about the face and neck. Both eyes were destroyed. The eyelids were inverted and drawn widely open. The mouth was retained open, and the under lip was inverted. (After E. J. Chance.)

then the extension should be carried out assiduously, for the older the cicatrix, the less extensible does it become.

Fig. 63.

'Front and back view of the cast of the foot and leg of a lad, aged 11, who had been severely burnt in infancy. This foot could have been replaced, but the lad considered it of too great value to him to permit me to do so, as he obtained his livelihood by showing it.' (After E. J. Chance.)

Treatment of Deformities from Contracted Cicatrices.

The following methods of treatment have been employed :—

1. Gradual and constant extension.
2. Extension by passive movements.
3. In suitable cases, the production of a fistulous opening, and subsequent division of the remaining band.
4. Plastic transplantation of skin from other parts.
5. Division of the cicatrix and of the skin near it, and extension of the parts.
6. Skin grafting.

(1) The instrument for extension must be worn constantly, the pressure being effected slowly, and care being taken to avoid producing sores. The form and construction of extend-

ing apparatus must vary with almost every individual case; and the ingenuity of the surgeon will be often taxed to apply such instrument effectually. This treatment is necessarily extremely tedious; and if the patient should be a growing child, the cost of alteration of instruments will be great. The results are sometimes satisfactory, but not always so. Mr. Holmes[1] mentions a case of badly-contracted arms which were 'quite restored to natural appearance and function' by the careful and continuous use of weights suspended to each hand.

(2) Passive movements have been sometimes successful; but can only be applied where leverage is possible.

(3) When the cicatrix is in the form of a web, a fistulous opening may be made at the base, as in the case of webbed fingers, and the tissue opened out and kept apart until the edges heal.

(4) Skin may be transplanted either from distant parts or from neighbouring parts of the cicatrix. Such operations are described in works upon general surgery. Mr. Wood urges the desirability of forming the flap, so that it can be turned in the course of any known subcutaneous artery. These attempts at transplantation of skin often fail, and when the skin has been taken from the neighbouring part and dies, the result is necessarily an increased deformity. Success would, perhaps, be more likely to ensue if only a slip of skin were transplanted at the edge of the cicatrix; and, if successful, a further operation could be performed.

(5) The whole cicatricial tissue is sometimes cut through, and the parts stretched out into their natural position with the object of filling up the gap with new material. But the effect is seldom good. Mr. Earle[2] and others have operated by making a transverse cut through the restricting band, and bringing the ends of the cut into apposition, and thus lengthening the cicatrix; and such mode of operation appears to have

[1] *Op. cit.* p. 281, *Dis. Children.*

[2] *Med. Clin. Trans.* vol. vii. p. 417.

been successful in some cases: but the results of this class of operations are not very encouraging.

(6) Considerable success has attended the engrafting of skin (Reverdin's method) upon the granulations which form upon the surface after[1] division of the cicatrix, so as to restore the parts to their normal position. The smaller the engrafts the greater the success. The reader is referred to works upon general surgery for further description of plastic surgical operations. The result of these operations depends greatly upon the general health of the patient.

Depressed Cicatrices.

Causes.—From glandular and other abscesses, necrosis, gunshot injuries, and other deep-seated morbid processes attended with much loss of substance.

Treatment.—Mr. Adams's plan consists in—

1. Subcutaneously dividing all the deep adhesions of the cicatrix with a tenotomy knife.

2. In carefully and thoroughly everting the depressed cicatrix; turning it, as it were, inside out, so that the cicatricial tissue remains prominently raised.

3. Two hare-lip pins are passed at right angles through the base of the cicatrix, so as to retain it in its position, for three days.

[1] See Holmes Coote in *Holmes's Syst. of Surgery*, vol. v. p. 590.

CHAPTER VIII.

HIP-JOINT DISEASE.

Synonyms—Latin, *Morbus Coxarius*; French, *Coxalgie* (κόξα and ἄλγος, pain); German, *Freiwilliges Hinken* or *Hüftweh*; Italian, *Coxalgia*; Spanish, *Coxalgia*.

THIS affection is well described by Billroth as *a chronic fungous and suppurative inflammation* of the hip joint, an atonic synovitis and ostitis commencing either in the synovial membrane, in the ligaments, in the periosteum, or in the bone.

Aston Key taught that the *ligamentum teres* is the structure first attacked;[1] Sir Benjamin Brodie thought that the disease commenced in the articular cartilage, and Furneaux Jordan considers that it always begins in the bone.

It is essentially a disease of childhood. But it sometimes occurs in later life, when it is said to be less severe and less dangerous.[2]

It is commonly considered to be a *scrofulous* affection, but it frequently occurs in children who do not present the usual characteristics of scrofula, and moreover the *cure* of the joint disease depends *more* upon local treatment than upon remedies applied to the general health. The remarks upon the ætiology of caries of the vertebræ, Chapter XI., apply also to morbus coxarius, and there it is stated that prolonged irritation of traumatically inflamed bone is likely to produce caries. Here

[1] *Med. Chir. Trans.* vol. xviii., also foot note. Hilton's *Lectures on Rest and Pain*, 3rd edition, 1880. Edited by Jacobson, p. 221.

[2] See Holmes's *Surg.* 2nd edition, 1878, and Dr. Taylor of New York.

again we may refer to Billroth, who states that '*when acute traumatic inflammation of a joint or idiopathic acute suppurative synovitis passes into the chronic stage,*' '*the same anatomical changes go on as in fungous inflammation.*'

Pathological Changes.—If the disease commences with synovitis, the membrane thickens and vascularises, the secretion is altered more in quality than quantity. The synovial tufts resemble spongy granulations which advance gradually over the cartilage, adhering to it, and 'eating it up' (Billroth). When the cartilage is consumed the fungous proliferations attack the bone and consume it in like manner, producing caries. The fungous granulations may also proliferate outwards. If the inflammation commences elsewhere, as, for instance, in the bone, proliferation occurs, and extends in the same manner as in the synovial membrane.

In severe cases the head of the femur, the acetabulum, or both, may be destroyed by caries. Necrosis of portions of the bones may take place, or the femoral epiphysis may be separated from the shaft; in the two latter cases the sequestrum interferes with repair in the joint.

Near the joint, and often some distance from it, the muscles degenerate and atrophy.

In children an arrest of development may take place in the surrounding parts, the pelvis often remaining small on the diseased side; this is especially the case when 'the disease occurs in or continues into the period of menstruation' (Hilton).

Caries may occur without suppuration, and is then called *caries sicca.*

Suppuration may be a symptom of slight degeneration of the synovial membrane, or of periarticular abscess, or of interarticular fungous proliferation.

In anæmic and in scrofulous subjects there is a great tendency to suppuration, the pus formed being of a very unhealthy character, and if the case recovers the process of repair is imperfect.

In subjects who are otherwise healthy there is a greater tendency to cicatricial contraction, and if caries occurs it may be without suppuration.

Causes.—All atonic conditions, and especially scrofula, predispose to the disease. Rheumatism is also a predisposing cause.

The exciting cause is usually, and perhaps always, an injury. Injury alone may give rise to the disease in a healthy child, either from traumatic inflammation becoming chronic, as stated above, or from interruption of the blood supply to the joint from rupture or contusion of the *ligamentum teres.* But whatever may be the primary origin of the disease, its increase depends chiefly upon continued motion of the joint.[1]

Symptoms.—The symptoms are usually described as belonging to three stages.

Stage 1.—The disease begins insidiously. There may be noticed an indisposition to play. Slight lameness, a 'limp,' which at first sight exists only in the morning, and 'wears off' during the day.

Pain is an important symptom, and in this early stage is usually felt chiefly or only upon the surface of the inner side of the knee and in the knee joint itself.

As the obturator nerve supplies both the hip and the knee joints, the knee pain is usually attributed to reflex irritation of that nerve, and doubtless such is the case.

Mr. Hilton supposed that the frequent presence of the obturator nerve symptoms indicates that the disease generally begins in the ligamentum teres. But pain is often felt by the patient in other parts.

[1] Barwell believes that genital irritation is often the cause of hip-joint disease. Phymosis in boys and vaginitis in girls.

Mr. Croft believes that tubercular disease may begin in the joints, and that early excision may prevent the system from becoming inoculated; but the good result following perfect rest is opposed to this theory, or at least is opposed to the treatment.

Some experiments were performed (Schüller, *Centralbl. f. Chir.* No. 19, 1879), which seemed to show the possibility of weak joints becoming afflicted with tubercle from injecting tuberculous matter into the lungs; but it is doubtful whether these results apply to ordinary disease of the joints.

The anterior crural nerve gives a branch to the anterior part of the capsular ligament of the joint, and thus we may get reflex pain upon the front of the knee or upon the inner side of the ankle, because this nerve sends branches to those parts; or there may be pain upon the inner side, at the back, and at the outer side of the ankle, and at the inner side of the knee from irritation of the sciatic nerve, which sends branches to these parts.

The patient rests the unsound limb in many different ways. The thigh will be probably slightly flexed. There may be some fever in the evenings and restlessness during the night, accompanied by spasmodic actions of the limb, and there is usually increased temperature in the region of the joint.

Some of the above symptoms may be absent, but if a careful examination be made the joint will be found *slightly stiff* (limited range of motion) *and painful if moved, pressed, or concussed.*

Bonnet, of Lyons, supposed that flexion and stiffness were caused by excess of fluid in the cavity of the joint, because when he injected the joints of a dead body, the limbs became flexed, abducted, and stiff; but in practice we find the flexion accompanied by muscular contraction, several muscles being implicated, and moreover the symptom is present when we may presume that little or no increase of fluid has occurred; and, upon the other hand, it is said that when there is effusion without pain, flexion does not often occur, and an inflamed joint is always more or less fixed and flexed.

The nerves that supply any joint are derived from the same nerve trunks that supply the muscles which move that joint. The importance which is attached to this anatomical fact has for many years been taught by Mr. Hilton,[1] and he records many instances in which the due appreciation of this distribution of nerves has enabled the surgeon to deal successfully with cases, the symptoms of which were otherwise obscure. The stimulation of the nerves of the joint from the irritation of the inflamed tissues is carried to the spinal cord and reflected to the

[1] *Lectures on Rest and Pain*, 2nd edition, 1880. Edited by Jacobson.

muscles which move the joint. All the muscles are irritated, but the flexors being the more powerful, as generally stated, or, as the author would say, possessing greater power from the advantage of their mechanical arrangement, overcome the other muscles, and so the joint becomes flexed and fixed.

If the inflammation has existed for long there will probably be some inflammatory new formation which will help to modify the movements of the joint, but muscular contraction and effusion into the joint are the chief causes of stiffness. The buttock of the affected side is flattened posteriorly, and the tumefaction in or around the joint causes the parts to protrude laterally. The gluteal fold slants downwards and outwards on the diseased side.

Stage 2.—This is called the stage of effusion by those who suppose that the flexion of the thigh is due to effusion into the joint. It has also been called the stage of abscess, but abscess is not always present, nor peculiar to this stage of the affection.

Pain, both at the knee and in the diseased joint, is severe, and consequently there is much lameness. Reflex muscular spasms are very troublesome, especially at night.

The thigh is flexed upon the abdomen, and is generally adducted and rotated inwards; or it may be abducted and rotated outwards. Sometimes it is flexed only. Apparent shortening is observed if the rotation is inwards, apparent lengthening if the rotation is outwards. The apparent shortening occurs when the pelvis is tilted to allow the patient to support himself slightly upon the toes of the unsound limb, seen especially in those who go about their ordinary work walking with a stick (Holmes Coote).

The apparent lengthening occurs from the child resting upon the sound limb, and allowing the pelvis to drop upon the diseased side. The position of the spinal column is usually that of incurvation (lordosis), when the patient rests both feet upon the ground because the psoas of the one, or of both sides if both joints are affected, draw inwards the lumbar vertebræ.

If the contracted muscles be relaxed either by raising the limb on the diseased side or by bending the body forwards, the incurvation disappears. If the patient has been walking about much, lateral curvature of the spine may be present as a consequence of the obliquity of the pelvis.

Stage 3 (the stage of real shortening).—The symptoms already described are increased. The reflex spasms are very severe. Sometimes, although rarely, there may be symptoms of spontaneous dislocation, in consequence of the upper rim of the acetabulum having been dissolved away by caries, and the contraction of the psoas having drawn the bone upwards. The result of this displacement, which is not pure dislocation, is actual shortening.[1] Sometimes the bone is displaced backwards.

In some cases the acetabulum gives way towards the pelvis, and the head of the femur enters that cavity. More or less fever is present at this stage of the disease.

Abscesses form and present in various situations: in the groin; at the outer part of the thigh; over the buttock; into the rectum, perineum, and in other directions.

After several or many days of acute pain, a sudden cessation of pain denotes rupture of the capsule of the joint.

A joint abscess may travel down the thigh and become disconnected with the joint.

Diagnosis.—Care must be taken to distinguish the disease from :—

1. Congenital dislocation and other congenital abnormalities of the joint.
2. Inequality of the length of the limbs.
3. Psoas abscess.
4. Inflammation of bursa.
5. Sciatica.
6. Hysteria.

[1] If the upper margin of the trochanter major is found to be level with, or only slightly above, a straight line drawn between the anterior superior spinous process of the ilium and the tuberosity of the ischium, there can be no dislocation.—*Nélaton.*

7. Rheumatism.
8. Sacro-iliac disease.
9. Paralysis.
10. Teething.[1]

Thickening of the acetabulum and enlargement of the head of the femur are sometimes mistaken for dislocation.

In forming a diagnosis, much importance is sometimes attached to pain at, and in, the knee joint from reflex irritation of the obturator nerve, and Mr. Hilton[2] has pointed out several other causes of this pain. They are :—

1. Disease of a vertebra near which the nerve lies.
2. Disease of the sacro-iliac articulation.
3. Psoas abscess.
4. Pressure upon the nerve from an overloaded colon, or a malignant or other tumour.

To detect the loss of free movement in the joint, one or other of the following plans may be practised.

Plan 1.—The child should lie flat upon his back, and both thighs should be flexed to nearly a right angle with the abdomen, the legs being allowed to flex upon the thighs. With a hand grasping each knee the surgeon should gently separate the thighs, when the difference in the movability will be discovered.

Plan 2.—The child should lie in the prone position with the legs flexed over the edge of a table. If each leg be now separately lifted (extended), the sound one will move independently of the pelvis; but that upon the diseased side will, when it has arrived at a certain point, carry the pelvis with it.

Plan 3.—The child being placed upon his back upon a table, the knees are raised as in Plan 1. A sound limb can be depressed until the popliteal space touches the plane without tilting the pelvis; but, upon depressing the thigh of which the hip joint is diseased, the pelvis becomes tilted, and the lumbar region raised from the table. In all instances a flat surface like a table should be used, and not a couch or bed.

[1] See Hilton, *op. cit.* pp. 341 and 343.

[2] *Op. cit.* p. 220.

Plan 4.—The patient being in the same position upon his back, the sound limb is flexed upwards upon the trunk as much as possible, the whole spine being in contact with the table.

FIG. 64.

Disease of the Right Hip Joint.

FIG. 65.

Incurvation of the Spine, produced by depressing the leg of the diseased side.

The patient is then directed to extend the diseased limb, which he will not be able to bring in contact with the table so long as the sound limb is retained in its flexed position. When the sound limb is released the other limb can be depressed, but the movement will raise the lumbar vertebræ from the table. This plan detects the exact degree of the flexion.[1]

Mr. Howard Marsh considers that rotation is a better means of testing the condition of the joint than either flexion or extension.

These movements of the limb must be modified in respect to the pain which they cause, which action often prohibits any but the most gentle and limited disturbance.

The author recommends the second plan as perhaps the best.

Sacro-iliac disease may be mistaken for hip-joint disease. It may cause stiffness of the joint from muscular contraction, the result of nerve irritation. There will be lameness, pain in the knee, ankle, and even in the hip: the obturator and

[1] H. O. Thomas states that 70° is reached in six weeks, and 100° in nine months.

sciatic nerves being influenced by the disease. Careful examination will detect the greater pain and increased temperature in the immediate region of the diseased joint, as well as the stiffness already described.

Hysteria (neuromimesis).—Under the influence of an anæsthetic, the muscles, both in the real and in the simulated disease, will become relaxed, but in the real disease the muscles, as Sir James Paget remarks, will 'become alert and restrain the movement of the joint before the patient has regained consciousness; while in the mimic disease there is no restraint till consciousness is completely regained.' If the flexion is the result of effusion into the joint the deformity will not be reduced by the anæsthetic.

However long hysterical pain may last the joint structures do not become changed.

The temperature of a joint is often considered a great help in diagnosis, as insisted on by Paget, Hilton, and others. A joint that is cold, or not above its natural temperature, says the former, is not an inflamed joint. But the converse does not always hold good. We must bear in mind, for instance, that extra-articular inflammation, such as that caused by an inflamed bursa, may increase the temperature, and also, as Shaffer, of New York, has pointed out, that nervous mimicry may produce congestion of a part, and cause an increase of temperature.

In examining the hip, as in the case of any other joint, care must be taken to give as little pain as possible to the patient, and the author protests emphatically against the mode of diagnosis recommended by Dr. Sayre, as follows :—'The erosion can be very easily detected by crowding the articular surfaces together, and slightly twisting them upon each other, when the most acute pain will be produced.'

Pain in the Knee.—In hip-joint disease the knee pain is more produced by light pressure than by moving the bones; but we must not forget that disease may be present in the knee joint as well as in the hip.

Prognosis.—Unless the disease has advanced far into the third stage and the health has been undermined, a favourable prognosis may be given. Symptoms of general scrofula may be present, and yet patients do well when the joint is perfectly rested, and cases occur even in which phthisical subjects recover from joint disease.

Some cases can be cured much more easily than others, although the symptoms at the time treatment is commenced may be similar. Such different results probably depend upon the tissues which are chiefly involved in the disease, as well as upon the vital powers of the patient.

In any case, if the internal parts of the joint are destroyed, and the articular surfaces of the bones are carious, repair can only take place by ankylosis, which may be fibrous or osseous.

If the case is far advanced in the second stage, or has entered the third stage, it will be impossible for the surgeon to determine the exact amount of destruction which has taken place in the joint.

Treatment.[1]

The health must be treated carefully upon general principles, but the local treatment requires our chief consideration. Much has been written upon the supposed benefits of fresh air and exercise in these cases, and if the constitutional symptoms were alone present, such remedies would doubtless be very desirable. Exercise, however, interferes with absolute rest to the diseased joint, and without such rest the results of treatment will not be satisfactory. It has, moreover, been found that the patient's general condition improves in proportion to the rest that can be given to the diseased joint, and this rest can only be satisfactorily effected by confining the patient to a bed or couch.[2]

[1] See Hilton, *op. cit.* p. 341, with regard to the importance of early treatment.

[2] We presume that the case has come under treatment before the health has been thoroughly undermined by extensive disorganisation of the joint and prolonged suppuration. In this advanced stage of the disease the question of out of door exercise would not be discussed.

In the majority of cases the constitutional disturbance depends upon the local disease, and if our measures are successful in controlling the latter the patient will improve in health, although he is obliged to maintain a constantly recumbent position.[1]

The writers of the first part of the present century advocated a treatment which essentially consisted in rest and counter-irritation.

Counter-irritation has gradually died out of use, and in the present day such remedies, when employed, generally consist in mercurial or nitrate of silver ointments and tincture of iodine.

Those who still employ the actual cautery—and so practical and experienced a surgeon as Mr. Holmes is among that number—apply it lightly. Leeches, and hot poultices, are also sometimes employed, and ice has been extensively used, as advocated by Esmarch, of Kiel.[2] Wet compresses are also recommended; but hot-water fomentations and turpentine liniment are probably the best topical remedies we can employ.

Opiates may be used as liniments, &c., or in the fomentation, and are strongly advocated by Mr. Hilton. This writer considers that the good effects of narcotics applied locally depend upon their influence upon the cutaneous nerves. These nerves are always associated with the nerves supplying the muscles of the joint beneath them, and also the joint itself and the action of the remedies thus applied is reflex.

Mechanical Treatment.

The following are the various principles upon which mechanical treatment has been employed by different surgeons :—

1. To fix and so to rest the joint.

2. To extend the limb by weight and pulley, and so attempt to relieve the inter-articular pressure.

3. To fix the joint and prevent tilting of the pelvis.

[1] Hilton, *op. cit.* p. 344, &c.

[2] Memoir translated for the New Sydenham Society.

4. To fix the joint and the pelvis in a position which is painless to the patient, and to gradually, day by day, move the limb into a normal position.

1. *To Fix the Joint only.*—Various splints have been employed, such as guttapercha, plaster of Paris, and moulded leather, and when skilfully applied and the patient is made to remain strictly recumbent, active disease has often by such treatment been arrested. But if the cases have advanced beyond the earliest stages at the time when this treatment is commenced, permanent stiffness of the joint, more or less complete, is the almost certain result.

These splints, moreover, do not perfectly control the movements of the joint, and failure in the observance of absolute recumbency causes more disturbance of the joint than is the case when the apparatus controls the movement of the spine upon the pelvis.

Extension of the limb by the weight and pulley apparatus is the mode of treatment which is perhaps most frequently employed in the present day. Some surgeons employ extension with the object of separating the articular surfaces from one another for the purpose of reducing inter-articular pressure. Others doubt the possibility of making this separation, but believe that the effect of extension is to overcome the spasmodic action of the muscles about the joint.

In America, Davis, Taylor, Sayre, and others have extolled the extension treatment, and they seem to consider that extension is the only object to be attained.[1] Bauer, however, states that he has found only unsatisfactory results from this treatment, and he fixes the joint and divides the spasmodically retracted muscles.

In this country, various splints have been used to retain the joint in a fixed position. When extension by weight and pulley

[1] With regard to Sayre's treatment, his own records condemn it. The large number of his cases which progressed badly, and necessitated (in his own opinion) excision of the joint, are sufficient proof that his system is not that which is best for the patient.

is employed, counter-extension is made either by a perinæal band or by securing the patient to the frame of the bedstead, or by the weight of the body when the lower end of the bedstead is raised. If the leg is flexed by the disease, the fact of endeavouring to place it in a straight position for extension by means of a weight and pulley will produce or increase inter-articular pressure—a fact which Mr. Howard Marsh first pointed out to me as follows :—

FIG. 66.

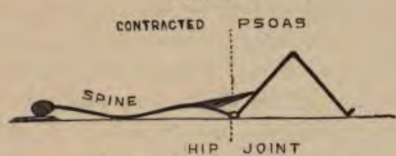


Diagram representing the Thigh flexed from contraction of the psoas muscle. The attachment of the muscle is placed rather lower upon the femur than natural, so as to show better the result.

If the thigh be depressed—that is, straightened upon the trunk—the femur will act as a powerful lever, the fulcrum of which will be the attachment of the psoas muscle, and the point raised, or pressed upon, will be the acetabulum. When the patient lies recumbent, with the leg straight, the retraction of the psoas draws up the lumbar vertebræ, producing incurvation (lordosis).

FIG. 67.

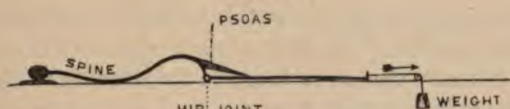


Diagram showing the effect of Forced Extension of a Flexed Thigh and the application of a Weight over a Pulley.

The psoas will then be drawn into a condition of extreme tension, thus producing inter-articular pressure.

If traction be now made in the direction of the long axis of the thigh, inter-articular pressure will be increased, because the force will tend to straighten the whole body, and, by bringing the hip joint towards the muscle, produce a closer adaptation of the articular surfaces.

Bonnet, as already stated, was the first to show that effusion into the hip joint caused flexion and abduction of the limb, and in many cases this condition is probably the chief or only cause of those fixed positions. Forced straightening in these circumstances is quite as harmful as where contraction of the psoas and other muscles is the sole origin of the deformity, for the position producad by the effusion is that which allows the greatest amount of space for the effused fluid, and a contraction of this space necessarily produces inter-articular pressure.

A more scientific mode of extension is that which employs traction *in the line of the deformity*; and this treatment is carried out very carefully at the Alexandra Hospital for Hip-Joint Disease, in Queen Square, Bloomsbury. The trunk of the patient is fixed in a recumbent position to the bedstead; extension by weights and pulleys is made in the desired direction, and counter-extension is made by raising the foot end of the bedstead. The perinæal band is not used.

The position of the leg is slightly altered day by day until the limb is brought down to a straight and natural position. When this position has been attained, extension is kept up in the straight axis for a certain length of time, after which the treatment recommended by Mr. Thomas, of Liverpool, is substituted.

That patients get well under this treatment is probably due to the fixed position of the diseased parts, and not to the extension. The theory that by such means the articular surfaces are drawn apart is probably fallacious, and many surgeons who employ extension do so, as already stated, with the sole object of controlling muscular spasms, and admit the impossibility of separating the articular surfaces.

One great objection to this plan of treatment is the irksomeness of the position to the patient and the loss of power which is produced from such a long-continued fixed position of the whole body.

If the traction is made by bandages fixed below the knee, the knee joint is much more likely to be extended than the hip joint; and cases are recorded in which it has been asserted that the knee joint has been deleteriously 'influenced by such traction.'

The fixed malposition of the limb may be, as we have already seen, either the result of effusion into the joint, or it may arise from irritation in the joint independently of effusion. Retraction of the muscles is in either case usually present.

In order thoroughly to fix the hip joint, the apparatus must control the movements of the pelvis, and this can only be effected by controlling the movements of the trunk. For this purpose, the long splint, reaching from the axilla to the foot, fixed to the thorax and leg, and having a perinæal band, was formerly the usual mode of treatment.

When the straight splint is used in the present day, the patient is usually placed first under the influence of an anæsthetic, and even then the use of considerable force is sometimes necessary before the joint can be straightened.

The objections to this plan of treatment are—

1. That it necessitates placing the limb in a straight position, the result of which is the production of inter-articular pressure, as already explained.

2. That this splint retains the joint constantly in one position and so favours ankylosis.

The effect of the long splint is no doubt better than that of leaving the joint unsupported, but it will not compare favourably with the treatment to be presently described.

There are, however, occasions when the long splint will be beneficial. That is when in advanced disease dislocation has occurred. In these cases it is advisable to administer chloroform, reduce the dislocation, and apply the long splint. Ankylosis usually follows, and is the best result which can be obtained.

The apparatus from which the author has seen the best results is that which Mr. Chance has employed at the City

Orthopædic Hospital for many years, but which is yet very little known to the profession. It will be described presently.

During the last few years, Mr. H. O. Thomas, of Liverpool, has introduced a mode of treatment very similar in principles to that of Mr. Chance. That is, he has recognised the importance of extending the apparatus as high as the shoulders, so as to control the movements of the pelvis, but his instrument does not restrain the incurvation of the lumbar vertebræ, and its frequent re-adaptation is difficult.

H. O. Thomas's Treatment.

This plan of treatment is based upon the following theories :—

That whatever may be the origin of hip-joint disease, the morbid state is kept up by movement of the joint.

That stiff joints are not the result of too long confinement in an immovable position, but are caused by inefficient and interrupted control of the diseased articulation and by permitting its use too soon.[1]

That extension is not only unnecessary but is harmful.

The following is a description of the apparatus employed by Mr. Thomas and the manner of using it :—

The patient standing, the foot of the diseased side is raised on books, &c., until the spine assumes a normal curvature (until incurvation is reduced). A long flat piece of malleable iron (1 in. $\times$ $\frac{1}{4}$ in. for an adult, $\frac{3}{4}$ in. $\times$ $\frac{3}{16}$ in. for a child) is taken, long enough to extend from the lower angle of the scapula to the lower border of the calf of the leg, slightly internal to the centre. This rod is bent by wrenches to the form of the body. A thoracic belt, made of hoop iron ($\frac{1}{2}$ in. $\times$ $\frac{1}{8}$ in.) is fixed to the top of the rod. A thigh belt of hoop iron ($\frac{3}{4}$ in. $\times$ $\frac{1}{8}$ in) is attached at one or two inches below the fold of the buttock. Another piece of metal of similar strength, equal to half the circumference of the calf, is united to the

[1] This idea is erroneous, as long-continued position of an inflamed joint will be very likely to be followed by ankylosis.

lower extremity of the upright. The part A which is on the diseased side is not to touch the side of the thorax, but the part B is to fit closely. If both hip joints are diseased, the apparatus should be made double, as in fig. 69.

FIG. 68.

FIG. 69.

Thomas recommends the double upright in bad cases, even when only one limb is affected. The apparatus is to be covered with boiler felt (No. 1 thickness) and basil leather.

'The patient being placed in the machine, a strap and buckle close the upper circle round the chest, and the limb is bound with flannel from the calf upwards, beyond the thigh circlet. The surgeon must be provided with suitable wrenches by which he can *himself* alter the apparatus to the exact shape of the body and limb, and make any alterations that may be subsequently required. The upright must have a rotation outwards and pass to the inner side of the popliteal space. This will prevent rotation inwards of the limb.

'Should the instrument rotate towards the diseased side and so become a side-splint, the surgeon should contract the longest wing of the upper crescent B and extend the short one; or if the instrument does not rotate, yet the stem is not over the prominence of the buttock and well behind the thigh, then the upright requires more twisting with the hooks (wrenches); or, if the trunk portion of the upright threaten to ulcerate the skin, the angle at C should be diminished until the portion from A to C is a plane surface. The patient is to be kept in bed during the acute stage of the disease. When this has passed and suppuration has been avoided, the patient is allowed

FIG. 70.

to go about on crutches with the apparatus still upon the limb, and an "iron patten, at least four inches in depth," placed under the shoe of the sound limb, as in the figure.'

'These must be continued until the limb is well atrophied around the great trochanter; the outline of which should be more discernible than that of the sound side.'

In the third stage of treatment, the apparatus is used only during the day.

In the fourth stage of treatment, the crutch and patten are used alone.

'Forcible flexion, extension, tenotomy, or chloroform, &c., are to be avoided as unnecessary.'

'The limb should be gently persuaded to come back from the erring position, and as it assents the wrenches "should be used to alter the hip instrument towards the normal lines."'

Mr. E. J. Chance's Treatment.

The principles upon which this treatment is based; the almost immediate relief from pain which the patient experiences when the splint is applied; and, above all, the good results which are ultimately obtained, have convinced the author of the excellence of Mr. Chance's plan of treating this disease.

The chief objects of treatment are :—

1. To subdue the inflammation.
2. To restore free movement.

The most important indication is *rest* to the inflamed joint, and immediately this rest is afforded pain generally ceases.

The best means for obtaining rest are :—

1. The prone couch.
2. The mechanical instrument.

Upon the prone couch the patient reclines in a position of perfect rest to the diseased joint. He can move his arms and body. He can play, read, work, and eat easily, and without disturbing the joint; whereas in the supine position on an ordinary bed, these occupations are accomplished with difficulty, and with disturbance of the diseased parts.

The mechanical instrument is constructed and used upon the principles of fixing the joint in the position assumed by the disease, and of moving it day by day, and by small degrees, towards a normal position.

To fix the joint, it is necessary to control the movements of the pelvis, and that cannot be perfectly accomplished unless the flexion of the trunk be also controlled.

This fact will be apparent if we consider the great leverage power of the trunk upon the thigh joint in comparison with the power of the pelvis alone upon the same joint.

If the apparatus reaches no higher than the pelvic belt, almost every movement of the trunk will move the pelvis, because the belt cannot be so firmly fixed upon this part of the body as to control the powerful leverage of the whole length of the spine.

Fig. 71.

In order to fix the spine, it is necessary to employ an abdominal belt. Without this belt the pelvis could become tilted by incurvation of the spine, a result which would especially occur when the psoas muscle was contracted.

The accompanying figure represents the principles of Mr. Chance's apparatus.

The instrument is constructed as follows:—A pelvic belt, A, is adapted below the iliac crests. An upright bar, B, passes from this belt to the height of the shoulders, and terminates in a pad. From this pad proceed straps C, forming armlets, or shoulder straps. From the pelvic belt proceeds a stem, D, which is fixed by a leather casing to the thigh, and the stem is movable by means of rack joints, E, in the directions both of flexion and extension, as well as abduction and adduction.

In applying the instrument the inclination of the joints should be adapted to the position in which the limb is held by the patient, and the apparatus must then be buckled on with as little disturbance of the joint as possible.

If this be done carefully the joint is immediately rested, and pain ceases at once, or very soon.

The next important indication in the treatment is to effect a gradual *redressement*, by moving the joint day by day, so as to bring the leg by degrees into a straight and extended position and to prevent ankylosis.

These movements require great care; they must always be made by the surgeon himself, and should always be stopped short of leaving the joint in a position which gives the patient pain.

As this adaptation proceeds, slight alterations in the straps, or other parts of the instrument, will generally be necessary, and the care and ingenuity of the surgeon will be called for to meet the requirements of individual cases. It will be to the advantage of the patient if the instrument and the couch both be employed, and, under no circumstances, should he be allowed to walk about.

Cases seen in very early stages of the disease may be treated by the couch alone, hot water fomentations and turpentine liniment being also employed.

In dealing with cases in which the disease is so far advanced when they come under treatment that ankylosis is a necessary result of cessation of the disease, the surgeon should endeavour to place the leg in a slightly bent position, that being probably a better one for all purposes than if the leg were fixed in a straight line. Some surgeons, however, consider that a straight position is the best.

When the patient has so far improved that the surgeon considers he may be allowed to leave the couch and get about, the side bar of the instrument is to be extended to the ground and attached to the sole of the boot, having a cog-wheel joint at the knee and a front stop-joint at the ankle. By this means the weight of the trunk is transmitted directly to the ground, and the hip joint is relieved from pressure, thus dispensing with crutches (see p. 132), which are necessary in Thomas's treatment of this stage.

For a long time, for many months at least, after all symptoms of disease have subsided, there remains a tendency to a return of the affection upon very little provocation.

A slight injury to the joint from a blow or a fall may re-establish the diseased condition, which was thought to be perfectly cured. Therefore, it is very important that the patient should be extremely careful for a long time after the disease has apparently ceased.

The supporting apparatus is a great safeguard against injury, and that which I have recommended, and just described, as invented and used by Mr. E. J. Chance, of the City Orthopædic Hospital, possesses the very great advantage over many others that it can be worn by the patient with perfect comfort.

Treatment of Abscess in or around the Joint.[1]—A distinction has to be drawn between the chronic and the acute form of abscess.

Acute abscess may form in the neighbourhood of the joint, and then requires early incision. It is chronic abscess in the joint, however, which more often requires our careful consideration in this disease. The development of chronic abscess is usually so slow, and the patient experiences so little pain and inconvenience from its existence, that cautious surgeons hesitate to evacuate the contents of the sac until the symptoms become urgent, that is, until the abscess either threatens to open spontaneously, or increases very rapidly. The reasons for avoiding an operation are, first, that inflammation of the walls of the sac or putrefaction of the pus is very likely to occur, and the effects of these accidents is very often fatal to a patient who is in a weak condition of health. The author has seen cases, in which chronic abscess had been present for several years, die from fever a few days after operation. Even if inflam-

[1] H. Macnaughton Jones, *The Lancet*, July 2, 1881.

mation does not supervene, we yet run a risk of increased suppuration occurring from the walls of the sac, and the patient may succumb to the drain upon his vital powers which this increased flow of pus will occasion.

Moreover, unless one or other of the above-mentioned indications for operation is present, the abscess, if left alone, may in time become absorbed.

The good results which the author has seen follow absolute rest to the joint when abscess has been present, lead him to defer operation until the symptoms clearly denote that evacuation of the pus is necessary. If the symptoms indicate a necessity for the removal of the fluid contents of the joint cavity, the aspirator may be used, but the case should then be closely watched, so that when the pus or other fluid re-accumulates, it may be operated upon without loss of time.

The re-accumulation often occurs very rapidly, and several or many punctures of the joint may be necessary. Mr. H. O. Thomas has well described the necessity of this repeated puncture, and he has found it desirable to operate once every twelve hours for six days in a case which was in time perfectly cured. Repeated removal of the fluid seldom fails to cause a cessation of the abnormal secretion. Some few cases, however, occur, which resist treatment by aspiration, and in these Mr. Thomas advocates a free opening of the sac—the surfaces of the wound to be kept open, and freely and frequently washed and anointed every few days with oil to prevent premature scabbing. Although this latter part of the treatment is not in accordance with the usual practice of modern surgeons, there is yet much to recommend it. If this plan of free opening, washing, and oiling is not adopted, the antiseptic system of Lister should be employed, or Mr. Callender's plan of evacuation of the pus and hyperdistension of the sac with a solution of carbolic acid (one part of acid to forty parts of water) may be tried.

The most dependent part of the abscess should in all cases be chosen for puncture, and the walls should be supported and brought into apposition by bandages or strapping.

Excision of the Joint should be left as a last resource. It is an excellent rule, as laid down by Mr. Holmes, 'that a large or important joint ought not to be excised while any reasonable prospect exists of a cure without operation.' This rule might well be taken to include every joint of the body.

In cases in which the patient is likely to succumb from general constitutional irritation, and in which thorough rest of the joint has failed to control the disease, excision may be desirable.

However severe may be the symptoms in any given case, excision should not be performed until such treatment has been tried and found ineffective, and the author believes that if thorough rest, in the manner advocated, were adopted early in the disease, the necessity for excision would very rarely occur.

Cases occasionally occur in which, as Mr. Holmes has pointed out, an operation is especially called for. These are cases in which the disease has produced necrosis of large pieces of bone; in some instances the head of the femur has been found separated from the shaft and from the ligamentum teres. Under such circumstances recovery appears to be impossible so long as the dead bone remains unremoved.

For details of operation the reader is referred to works upon general surgery, and especially to Mr. Holmes's 'System of Surgery,' and to his remarks upon excision of joints at the meeting of the British Medical Association at Cambridge in 1880.

CHAPTER IX.

ANKYLOSIS AND OLD UNREDUCED DISLOCATIONS.

Ankylosis.—Synonyms—French, *Ankylose*; German, *Gelenkverwachsung*; Italian, *Anchilosi*; Spanish, *Anquilosis*.

Ankylosis.

Ankylosis or stiff joint may depend upon one or more of the following conditions:—

I. Osseous union of the articular surfaces.[1] This kind is also called true ankylosis or synostosis. The union may be more or less extensive. It is usually an acquired affection; but it has been known to be congenital.

II. Cicatricial adhesions between the articular surfaces, formed of connective tissue.

III. Adhesion of the walls of the synovial sac which line the folds of the capsule, formed in the direction to which the limb is bent. (See Henle's 'Anatomy.')

IV. Osseous deposits formed in the joint.

V. Alteration of the articular surfaces by ulceration of cartilage or bone; restriction of movement being caused by unevenness of the contiguous surfaces.

VI. Cicatricial contraction of the articular capsule and of the accessory ligaments.

VII. Fibrous bands from inflammatory new formation within the joint.

VIII. Extra-capsular (spurious) ankylosis. Fibrous adhe-

[1] See Billroth's *Surgical Pathology and Therapeutics.*

sions between bones, muscles, tendons, &c. Exostoses, muscular contractions.

If a joint of a limb is not properly supported during severe inflammatory affections, dislocation, more or less complete, may occur. This complication may be caused either by contraction of the flexor muscles, or from the weight of the limb, or from other causes producing malposition of the limb. This condition is called compound ankylosis.

Causes of Ankylosis.

1. *In Old Age.*—Osseous growths or loss of elasticity in ligaments, the joints mostly affected being the costovertebral, intervertebral, and sometimes the carpal, tarsal, sterno-clavicular, and others.

2. Structural changes, the result of inflammation, either general, traumatic, or specific inflammation, but especially *scrofulous*, *rheumatic*, *gouty*, and *syphilitic*. The disease called gonorrhœal rheumatism produces very severe and often intractable ankylosis.

3. Pressure has been supposed to give rise to ankylosis. In lateral curvature, for instance.

4. Long-continued repose of a joint in one position. This form of ankylosis is usually spurious; but a case of fibrous ankylosis, presumably from this cause, is recorded by Mr. Butlin.[1] The last of these causes calls for further remarks.

Stiff finger and wrist joints often occur after long confinement in one position in cases of fractured forearm, and it becomes a question as to the cause of such stiffness. If some inflammatory action is occasionally set up in these joints, such result is certainly not always the case. Possibly the œdema which generally occurs in the hand under such circumstances may have an influence.

When œdema occurs, the individual fibres of the connective tissue are separated by effused plasma, which is well shown in a drawing by the author, from a preparation made by Dr.

[1] *Path. Soc. Trans.* vol. xxv.

Klein, in the 'Atlas of Histology,'[1] and if this condition should exist for several weeks, we may presume that its effects will be more or less organisation of the plasma and adhesion between the fibres.

Sir James Paget[2] records the case of a gentleman who, in 'a half-lunatic condition,' remained in a sitting posture for five years. 'At the end of this time his knee joints were contracted to a right angle, and felt as if absolutely fixed.' . . . 'After some weeks of extension with instruments, the knees were straightened, and power over them was completely gained.'

Sir James Paget has described other cases in support of this view.

This subject has received considerable attention on the Continent. Teissier,[3] Menzel,[4] and Reyher[5] have published the results of their researches upon this subject.

Mr. Jacobson[6] refers to these publications, and remarks that Teissier asserted that long-continued immobility may produce—'1. Escape of blood or serum into the cavity, into the subsynovial cellular tissue, or into the soft parts outside the joint. 2. Vascular injections of the synovial fringes, with formation of false membranes. 3. Alterations of the cartilage, e.g. swelling, softening, and erosion. 4. Ankylosis; this is shown to be not only frequently fibro-cellular, but in one case at least, where the thigh was amputated for non-union of a fractured femur after twenty-two months of extension and immobility, it is proved that actual fusion of contiguous articular surfaces may take place.'

M. Teissier believed that immobility of the joint caused suppression of the synovial fluid, which further caused engorgement of the joint structures.

[1] *Atlas of Histology,* pl. viii. fig. xiv., described on p. 33, by E. Klein, F.R.S., and E. Noble Smith. London, 1880.

[2] *Clinical Lectures,* 2nd edition, edited by Howard Marsh, 1879, p. 213.

[3] *Gaz. Médicale,* Sept. 25, Oct. 2, 1841.

[4] *Arch. für Klin. Chir.* Band xii.

[5] *Deutsche Zeitschrift für Chir.* B. iij.

[6] Foot note to Hilton's *Lectures on Rest and Pain,* 3rd edition, p. 321.

Menzel confirms these observations.

Dr. Reyher found that 'in certain cases, especially where the immobility has been from time to time interrupted, ulcera tion of the joint cartilage takes place.'

Mr. Jacobson further remarks that, 'in rightly estimating the effects of rest itself in such cases, due weight should be given to the following points:—1. That in a certain proportion, e.g. where the joint changes have followed prolonged treatment for fracture, the primary injury may have set up mischief in the joint, unnoticed at the time. 2. The possibility of the pre-existence of a constitutional condition predisposing to arthritic changes. 3. The proneness of certain joint cartilages, after young adult life, to show signs of commencing degeneration.' Mr. Bruce's[1] account of changes in articular cartilages is referred to.

Diagnosis.—We must distinguish between stiffness, the result of existing inflammation, and that which is the result of morbid processes which have subsided.

Pain in a joint, upon movement, caused by inflammation must be distinguished from pain the result of stretching adhesions, or, if there is subluxation, from undue straining of the ligamentous structures.

The voluntary fixing of a joint by the patient must not be mistaken for permanent stiffness.

Upon attempting to move an ankylosed joint pain may be an indication that osseous ankylosis does not exist. especially if the pain occur upon the aspect *from* which it is being forced.

Diagnosis of the Character of the Ankylosis.—If the result of synovitis (acute, sub-acute, or chronic), the adhesions are usually within the joint. In rheumatic cases they may be external or internal.

True bony ankylosis is less common in ball and socket articulations than in others; very rare in jaw and shoulder joints. In the hip and shoulder the mobility of the pelvis and scapula sometimes render the diagnosis difficult.

Chloroform is a great assistance in determining between

[1] *Path. Trans.* vol. xx.

osseous and ligamentous ankylosis, but is not infallible. Osseous ankylosis is the exception.

Immobility does not necessarily indicate bony union, but there is a certain degree of elasticity in the one case not present in the other. It has been stated that, if by pressure tendons can be made prominent of muscles brought into action, some movement in the joint must be present. But muscles which pass over another joint as well as over the ankylosed one may be brought into action by such manipulation, and if an anæsthetic is not employed, the patient may contract a muscle independently of moving the joint. In bony ankylosis the patient feels a greater shock from percussion upon the extremity, but this is only a relative symptom.

Gentleness should be observed in examining a joint, as rough movements may excite muscular contraction, which will limit, more or less, the degree of motion of the joint. Moreover, if any active disease be present, or has only lately subsided, rough handling might be productive of considerable mischief, or, at the least, might give unnecessary pain.

Treatment.—In true (osseous) ankylosis the only available treatment is division of the bone for reunion in an improved position, or an attempt may be made to form a new joint. With the first object the operation may often be performed with benefit, but with the latter the result is very uncertain, unless only a few spicula of bone interfere with motion.[1] In the elbow joint, however, operation is usually successful.

For other forms of ankylosis. If slight and extra-capsular, frictions, passive movements, steam vapour baths, oleaginous embrocations, shampooing, and gradual movements by means of mechanical instruments may be employed.

[1] During active and severe disease of a joint, where the degree of disorganisation necessitates ankylosis, the joint should be placed in the position in which it will be most useful to the patient as a stiff joint. For the hip and knee, slight flexion of those joints is best. For the ankle, the foot should be placed at right angles with the leg. For the elbow, sufficiently flexed for the hand to reach the mouth, with the hand half-way between pronation and supination.

The tendons of contracted muscles or bands of fascia may often be divided subcutaneously with advantage, after which the limb should rest supported for several days, or until the external wound has healed, before any further attempt at reduction of the ankylosis is made.

Mechanical extension, by means of instruments adapted to the limbs and with cog-wheel joints, is applicable to some cases, but should not be continued if much pain is caused by it.

Forcible Reduction of Ankylosis (*Brisement forcé*).

This treatment requires great discrimination and judgment, and if undertaken, the following conditions are imperative :—

1. The general health of the patient must be good.
2. Several months should have elapsed, after active inflammation has ceased, before such treatment is adopted in any case; and
3. When the case has been associated with a scrofulous diathesis, it is safer not to employ this mode of treatment until several years have elapsed, nor until the patient has been perfectly restored to health.

In early life great care is necessary to prevent injury or separation of the epiphyses from the shaft, before their union has become completely ossified. Bauer had to amputate in consequence of separation of the epiphysis of the tibia in a youth aged 16, and he states that the force employed was gentle.[1] Other cases of ankylosis upon which he operated made good recoveries.

Originally mechanical apparatuses were employed for straightening limbs by *brisement forcé*; but Diffenbach introduced the practice of using the hands only. The former means should, except under exceptional circumstances, never be employed.

Langenbeck was the first to employ anæsthetics in order to paralyse the muscles, and to remove pain while the adhesions were broken down. He considered that anæsthetics would render the divisions of tendons unnecessary in these cases.

[1] *Orthopedic Surgery*, by Louis Bauer. New York, 1868.

Brodhurst, however, prefers to divide all tense tendons, and bands of fasciæ, and he lays down the following rules foı breaking down adhesions :—

1. That cicatrices, tense fasciæ, and tendons of contracted muscles, if present, are to be subcutaneously divided, and the punctures allowed to heal, before forcible flexion or extension is employed.

2. That the muscles are to be quite paralysed by the anæsthetic.

3. That moderate force alone is to be used, and generally with the hands only (without instrumental aid).

4. That the adhesions should be ruptured by flexion in preference to extension, because flexion is the safest. If the epiphyses are yet ununited to the shafts, Bauer advises extension as safer than flexion.

5. That, after breaking down the adhesions, no attempt should be made directly to restore the position of the limb, nor to examine the state of the joint. But the joint should be immediately fixed by some retentive splint or other apparatus, which has been prepared beforehand.

6. The joint should remain at rest until all tenderness about it has ceased. Several days should always intervene. Gentle movement should then be commenced, and repeated at intervals, the length of these intervals varying according to the progress of the case, the manipulations being made daily, or every second or third day ; or longer intervals may be necessary. If these movements occasion pain, hot-water fomentations or the hot-air bath may be sufficient to relieve the patient ; but it is often necessary to readminister an anæsthetic.

If any tendons have been divided, the extension must be very gradual, so that they shall not be overstretched. The muscular rigidity which is present in some cases, especially in those arising from rheumatic inflammation, is more difficult to get rid of than the ankylosis itself.

For producing anæsthesia, chloroform or ether is usually required ; but nitrous oxide gas may be used in many cases.

Subsequent treatment by passive motion, friction, hot-air baths, or other emolients, may be necessary before the normal condition of the joint can be completely restored. In many bad cases free motion is never completely restored, and there is often a tendency to refixation, so that in such cases improved position is the chief or only result effected.

Although deprecating the employment of mechanical apparatus for the reduction of ankylosis, Mr. Brodhurst remarks upon an exceptional case, in which he employed instrumental assistance for operating upon the hip joint with success, after attempts to relieve the patient by hand alone had failed; also in a case of ankylosis, in which the tibia was partially displaced backwards, Mr. Brodhurst used an apparatus with success, which effected flexion, by using the posterior surface of the knee as a fulcrum; and it would seem to be, perhaps, a safer means of treatment than by movements with the hands.

Ankylosis of the Knee Joint.

Sometimes the patella is united to the femur. This is a serious complication. If the joint is ankylosed in a flexed position, and the patella is united to the femur by fibrous attachment, attempts at reduction are likely to result in dislocation of the tibia backwards, and even if reduction is accomplished, the restoration of the functions of the extensor muscles is generally impossible.

Some cases of false ankylosis resist all attempts at reduction.

If the tibia is partially displaced backwards upon the femur (and perhaps rotated outwards), the upper extremity of the leg must be brought forward during extension, for if the leg be only extended upon the thigh, complete dislocation may be produced. For example, if the bones are placed as in fig. 72,

Fig. 72.

the effect of extension might result as in fig. 73.

FIG. 73.

This accident may be avoided by using the apparatus above referred to.

Ankylosis of the Ankle Joint.

The position assumed by the foot during inflammatory affections of the ankle joint often simulates talipes valgus or talipes equinus or equino-varus. The former position may be produced by walking, and the latter by the weight of the foot alone, or by pressure from bed-clothes. *Diagnosis* is to be made between these cases and talipes the result of muscular contraction, and deformity from fracture.

Ankylosis of the Jaw.

Causes.—The same causes that produce ankylosis in other joints may also affect the temporo-maxillary articulation; but the causes of inflammation which are peculiar to this region are irritation from affections of the teeth and alveoli, mercurial salivation, and cancrum oris.

A case of extension of inflammation from the ear, the result of measles, is recorded by Mr. Heath,[1] and a case of osseous ankylosis accompanying disease of the cervical vertebræ is given by Mr. Hilton.[2] Mercurial salivation, cancrum oris, and other affections which lead to the formation of cicatrices of the mucous membrane of the mouth, are likely to produce closure of the jaws.

Esmarch [3] describes the elastic nature of the mucous mem-

[1] *Injuries and Diseases of the Jaws*, 2nd edit., London, 1872.

[2] *Lectures on Rest and Pain*, 3rd edit., by Jacobson, London, 1880.

[3] *Die Behandlung der narbigen Kieferklemme durch Bildung eines künstlichen Gelenkes am Unterkiefer*, Kiel, 1860.

brane of the cheeks, which allows the joint to be opened wide. If this elasticity is lost, by the transformation of the mucous membrane into fibrous cicatricial material, the range of motion of the jaw becomes restricted, and in the course of time contraction of the cicatrix causes complete ankylosis of the temporo-maxillary articulation. Contraction of the muscles may sometimes be the cause of closure of the jaws.

FIG. 74.

Barrett's instrument (after Dr. Little).

Treatment.—For osseous ankylosis (a rare condition) a false joint must be made. It is difficult to reach the neck of the jaw, so that in the majority of cases it is advisable to make a false joint by dividing the ramus as high as practicable.

For fibrous ankylosis forced movement may be adopted. Barrett's apparatus is a very convenient form of wedge for forcing the mouth open, but other forms of screw apparatuses are used.

For ankylosis from contracted cicatrices there are two kinds of operation, which consist in—

1. Dividing and stretching the cicatrix.
2. Dividing the jaw, and forming a false joint.

(1) Operation upon the cicatrix can only be performed when the tissues of the cheek beyond the mucous membrane are not involved in the fibrous new formation.

To prevent re-contraction of the cicatrix after its division, it is necessary to adopt 'shields,' to fit on to the antagonistic surfaces of the jaws.

The process is very tedious and painful.

(2) Esmarch's operation consists in removing a small piece of bone from the jaw, *in front* of the cicatrix, and forming a false joint; Rizzoli's operation is simple division of the jaw without removing a piece of bone. The former is more likely to be successful than the latter, as there is a great tendency to reunion of the bone.

Esmarch's operation is suitable where one side of the jaw only is affected. It gives 'the patient a very useful, though one-sided, amount of masticatory power in two or three weeks, and with very little suffering or annoyance.'[1]

Ankylosis may be dependent upon or complicated by contraction of the masseter, in which case it may be necessary to divide that muscle.

Ankylosis of the Hip Joint.

If the ankylosis is osseous, an operation may be performed for the purpose of obtaining a stiff joint in an improved position, or with the object of producing a false joint. The attempt to produce a false joint may fail, and if successful, the usefulness of the limb may possibly be less than if the junction had become osseous. Cases have been reported, however, in which both a movable joint and a useful limb have been obtained. Mr. Gant has had some good cases of this kind: he divides the bone between the two trochanters. Dr. Sayre has excised a transverse plate of bone from the neck of the femur, and produced a false joint; and Mr. William Adams divides the neck of the bone subcutaneously. Rhea Barton, of Philadelphia, was the first to operate in these cases: he divided the neck of the femur by open wound. Mr. Brodhurst has also recorded some cases.

Spurious Ankylosis

Is caused by fibrous adhesions between bones, muscles, tendons, and other tissues in the neighbourhood of a joint, also by exostoses and muscular contractions. If adhesions take place sufficiently near to any joint to limit its normal range of motion, the condition is called spurious ankylosis. It is unnecessary here to enter minutely into the great variety of conditions which may exist; but with regard to one of the varieties of spurious ankylosis, viz. *stiff joints following the usual treatment for fracture of one or other of the bones of the*

[1] C. Heath, *op. cit.*

extremities, a few remarks are necessary. Much might be done to prevent the occurrence of these stiff joints, by frequently applied passive exercise of the parts. If the fracture is situated very near to the joint, the difficulty of employing passive motion is, of course, proportionately great, and Colles's fracture of the forearm has been considered to be one in which no movement of the hand ought to be allowed.

The writer has, however, devised a plan for making the part of the pistol-shaped splint, which is in conjunction with the fingers, movable opposite the respective joints, and so allow passive movement to be made without disturbing the setting of the fracture.

A splint has also been invented by Dr. Carr, an American surgeon, for the treatment of Colles's fracture, and the results attained from its use are reported to be very good.

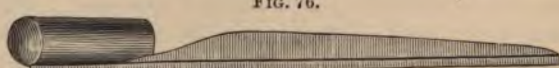
It is said to 'relieve the patient from much discomfort and disability, allowing him to use his fingers and thumb, and thus, by the excellent position obtained, preventing the stiffness frequently occurring after this fracture.'[1]

I am indebted to Messrs. Krohne and Sesemann (the makers of this splint) for the following illustrations.

FIG. 75.

Splint for the Right Arm, seen from the surface.

FIG. 76.



Splint seen in profile.

[1] *British Med. Journal*, April 9, 1881, a description of some cases treated at University College Hospital, by Mr. Christopher Heath.

The Manipulations of Bone setters

Are usually directed to the breaking down of some slight adhesion, which has caused considerable pain upon movement of the joint.

Cautious movements of the joint when such adhesions exist may have the effect of setting up slight inflammation, whereas forcible movements, sufficient to break down the new tissue, will generally be followed by immediate cure.

In this class of stiff joints the movements are retarded more by pain than by mechanical impediment, and this pain is usually referred to one or more circumscribed localities.

The tender spot is to be pressed upon by the thumb of the surgeon, while the joint is suddenly and forcibly moved in the direction which is painful to the patient.[1]

The painful spot is probably one fixed point of an adhesion, and if this should be upon one of the small bones of the carpus, the thumb pressure will prevent the bone being displaced during the flexion of the joint. Fixation of the painful end of the adhesion will also help the rupture of the adventitious band instead of allowing it to be torn from its attachment, the former result being less likely to be followed by pain and inflammation than is the latter.

These manipulations are usually very painful, and the use of nitrous oxide gas will often be desirable.[2]

If a case of long standing or one which for any other reason presents a probability of difficulty has to be operated upon, it is advisable to employ poultices and hot water fomentations for several days before attempting to break down the adhesions.

Old Unreduced Dislocations.

Although the dislocated articular extremities of the bones in unreduced dislocations will, in the course of time, adapt themselves partially to their new positions, yet perfect move

[1] *Bone-setting (so called)*, by W. P. Hood, 1871.

[2] See Howard Marsh, *Medical Times and Gazette*, April 17, 1880.

ment will not be regained. A new cavity is formed by effusion of plastic lymph, which becomes transformed into cicatricial connective tissue, which partly ossifies. The cartilage generally becomes rough and fibrous, and adherent to the parts upon which it rests by cicatricial connective tissue. The muscles will be thrown more or less out of use, and will atrophy proportionately. Usually there is a tendency for the margins of the old socket to become depressed, and the cavity to fill up with fibrous or osseous tissue. This process, however, is very slow, and does not always take place. Fournier found the depth of the acetabulum and the condition of its cartilage unimpaired, although the femur had been dislocated for thirteen years.

The displaced articular end of bone either becomes covered by porcellaneous deposit, or an imperfect fibro-serous surface, or surrounded by a synovial capsule.

Bony deposits may take place in the tendons and other fibrous structures around the false joint.

Tendons will be displaced, and may form attachments to surrounding parts. Tendons, moreover, may be, as Mr. Holmes has described, split by the accident.

The Length of Time after Dislocation at which Reduction is Possible.—This depends upon the nature of the injury and upon the changes which have taken place since its occurrence, and these points can seldom be diagnosed accurately until attempts at reduction are made. It may be impossible to replace the bone even soon after the accident, in consequence of reunion of the capsular ligament having taken place. But, upon the other hand, the shoulder dislocated backwards has been replaced at a period of more than a year after its dislocation, and in another case of the shoulder two years after the accident; the hip on the seventy-eighth day; the wrist six years after the accident;[1] the scaphoid seventeen years after displacement.[2]

Treatment.—The patient being fully under the influence of

[1] See Holmes, *Syst. Surg.*

[2] The Author, *Brit. Med. Journal*, March 20, 1880.

an anæsthetic, the adhesions which hold the head of the bone in its new position are to be broken down by movements in various directions, only moderate force being applied. Reduction can then be effected in accordance with the ordinary rules of surgery. Passive motion should be commenced as soon after reduction as it can be done without causing pain.

In some cases the muscles may have become contracted, when it becomes necessary to divide their tendons. Under such circumstances three or four days should elapse, to allow the punctures to heal before attempts are made to break down adhesions and reduce the dislocation.

The trunk of a large artery has been known to adhere firmly to the capsule or periosteum of a displaced bone (*Hamilton*); and fatal hæmorrhage from laceration of the artery has occurred in consequence of attempts to reduce dislocations of the shoulder joint under such circumstances.

Joints such as the shoulder, which from their construction are easy to reduce, are less likely to regain strength when returned to their proper place than joints such as the hip, the reduction of which is more difficult.

If the head of the humerus has affected the nerve of the axilla by pressure, and reduction cannot be effected, it may be necessary to resect the head of the bone.

CHAPTER X.

DEFORMITIES OF THE SPINE.

The Spine.

The spinal column is admirably adapted for fulfilling the combined purposes of protecting the spinal cord and of affording a basis of support for the whole trunk. It is a strong yet flexible column, which can be moved in any direction by the muscles which are attached to it, or fixed by these muscles in such a manner that support is given to the rest of the body in a great variety of positions.

Viewed from the side, the spine is so shaped that it forms an anterior curve in the neck and loins, and a posterior curve in the back.

These curves vary slightly in degree in different individuals. They are due partly to the shape of the bodies of the vertebræ, and partly to the intervertebral substances.

The curves of the spine weaken it as a supporting structure (although Rollin and Majendie have asserted the contrary), but enable it to sustain a greater amount of violence without injury than if it were perfectly straight.

This advantage, derived from the curves, is exemplified when an individual leaps from a great height. The shock upon alighting is disseminated through the column by an increase of the curves as well as by the elasticity of the intervertebral discs.

A slight dorsal lateral curve to the right has been described as a normal condition of the spine. Quain and Sharpey, Bichat, Béclard, Otto Bühring, and others offer various explanations of this condition, the majority considering it the effect of muscular action; but Little, Adams, and other modern observers, after careful enquiry, have satisfied themselves that there are no obvious *natural* lateral curves in healthy persons.

Fig. 77.

Natural Curves of the Spine.

The intervertebral discs together form about a fourth part[1] of the length of the spinal column; but they are thicker in the cervical and lumbar region than in the dorsal, such arrangement being in conformity with the greater freedom of motion which exists in the neck and loins than in the back.

In the neck and loins the discs are thicker in front than behind, and are thus the chief factors in the curves which belong to these regions; but in the dorsal part of the spine the surfaces of the discs are nearly parallel, and the dorsal curve is formed chiefly by the shape of the bodies of the vertebræ.

The intervertebral bodies are very elastic, but do not possess the power to resume their full thickness after compression, while the body remains erect. They collectively lose by compression about three-quarters of an inch in the course of one day, and a recumbent position of from six to eight hours is necessary to allow them to regain their complete extension.

This peculiarity of the intervertebral discs is, as Bauer remarks, 'no doubt operative in the establishment of distortion of the spine.'

It is not considered necessary in this work to describe the ligaments which unite the vertebræ to one another; but it may be well to remind the reader of the elastic nature of the ligamenta subflava, which unite together the laminæ, and which,

[1] W. and E. Weber state one-fifth.

after flexion of the spine, tend to restore the column to its former position, a much smaller expenditure of muscular force being required for this purpose than would be necessary without their assistance. These ligaments act, therefore, like the ligamentum nuchæ of the herbivorous and carnivorous animals.

The spinal column can be moved anteriorly, posteriorly, or laterally; or these movements may be combined in circumduction. The whole spine can also be rotated upon its own axis.

In *rotation* the front of the cervical vertebræ may turn to one or other side. This effect is produced by each vertebra twisting very slightly upon the one below it. The movement must always involve many, if not all, the vertebræ.

The muscles of the spine are brought into action for a great variety of purposes. Besides the varied movements of the column itself, many movements, ordinarily supposed to belong entirely to the extremities, take a direct basis of action from the spine; and in order to use muscles which have no direct communication with the spine, others which are attached to this column must often be in the first place 'fixed.'

The muscles of the back are very extensive and varied in their arrangement, so that all the movements which have been described above can be carried out by them. In fact, the muscles, if sufficiently exercised, are capable of performing a greater degree of movement than the ligaments of the spine will ordinarily permit.

Acrobats, whose ligaments have been freely stretched, are able to control by muscular action any position to which their vertebral column will extend. These performances denote great strength with much laxity of ligaments, and go far to prove that the strength of the back, and the power to maintain it in an upright position, depends more upon a healthy condition of the muscles than upon the strength of the ligamentous structures; and we may consider that the characteristic erect position of the human body is maintained by the muscles which surround the spine.

Mr. Adams[1] has stated his opinion, that the erect position of the spine is not maintained by *active tension* of the muscles, but that it would be more correct to describe them (the muscles) 'as in a state of *vigilant repose*, ready on the instant to check and limit the flexion of the spine when its balance is disturbed.' Notwithstanding Mr. Adams's usual accuracy of research, the author ventures to offer the following reasons for differing from this view:—

The lax condition of the spinal and other joints of the body in a dead person, or in one temporarily insensible, renders it impossible to keep the spine of such a person in an upright position, even when the individual is seated in a chair. This condition of the body is the result of inaction of the muscles, and, therefore, the author believes that when an individual holds his spine erect, some muscular exertion is always exercised.

The Undeveloped Spine.

The foregoing description refers chiefly to the fully developed spine—the spine of the adult. As we meet with disease and distortion chiefly at an early period of life, before the spine is fully developed, it is desirable to consider the condition of the column during its period of growth. At birth each vertebra consists of three bones, united by cartilage. The osseous laminæ unite behind during the first year, and the body is joined to the arch about the third year. The centres of ossification for the transverse and spinous processes do not appear until the sixteenth year; and those which form the thin plates at the upper and under surfaces of each body, not until the twenty-first. All these parts are not thoroughly joined together, and the bone completely formed, until about the thirtieth year.

During this period of growth the spine is more susceptible to injury and deformity than after it is fully formed, the various portions of bone being even liable to complete separation one

[1] *Lectures on the Pathology and Treatment of Lateral and other Forms of Curvature of the Spine*, by W. Adams, London, 1865.

from another, as a consequence of injury. The spine is more flexible, and the normal curves are only partially developed; in fact, in the infant there are no physiological curves.

Excurvation (Posterior Curvature of the Spine).

This deformity may occur at any age; it is common in infancy, and generally occurs to some extent in old age; and in the latter instances it is often considered a natural result of senility. In infants the whole body may seem to be affected by debility, and the child, when placed 'sitting up,' is unable to maintain the position. If the case is not quite so severe, and the child can remain 'sitting up,' there is a general backward *bow* of the spine, and the spinous processes of a few or many vertebræ will project, causing the skin to be stretched over them. This curve can, in the early stages, be removed by an alteration in position; but, in the course of time, the anterior portions of the vertebræ and intervertebral fibro-cartilages are retarded in their development, or become absorbed, because they are subjected to a greater amount of pressure than the other part of the vertebræ, and so the curve becomes more or less perpetuated. The bones and cartilages are thus converted into wedge-like forms, and, as the curve increases, so does its tendency to get worse increase.

The dorsal muscles become elongated; the positions of the abdominal and intercostal muscles and diaphragm are altered, so that the functions of the thoracic and the abdominal organs, and especially of the former, become deranged;[1] the power of inspiration becomes lessened, and the action of the heart is impeded.

At the commencement there is usually some pain in the back, and a general sense of weakness in the dorsal muscles, especially after exercise, when exercise can be taken.

In children the period of walking is deferred; or, if the child

[1] See Bampfield, *op. cit.*, and Brodie, *On the Joints*, p. 285.

has commenced to walk, it looses its activity, stumbles and falls about, and is soon tired.

The general health becomes impaired.

Causes: in infants.—This deformity is caused by general debility affecting the dorsal muscles.

In *youths* and *adults*, also, it may be the result of weakness, or of long continuance in the stooping position, independently of weakness; or it is said to be sometimes a natural conformation of the body.

The *treatment* in infants should consist in the application of a splint moulded to the back, made of leather or guttapercha, lined with some soft material, and attached to the body by a broad abdominal belt and armlets, as shown in the figure.

FIG. 78.

FIG. 79.

Guttapercha Splint applied to a Child's Back.

The general health will also require attention. The splint is to be used until the child has become stronger.

In youth, treatment by drilling and various gymnastic exercises, and cold bathing, usually suffices to cure the deformity; but in some cases, especially in girls, it is necessary to adopt a mechanical apparatus. The simplest apparatus consists of shoulder straps attached to a stiff central pad, which projects over the scapulæ, and bands passing down to a belt, or a well-padded backboard with arm straps and belt, or a slight steel upright attached to a pelvic band, and having an abdominal belt with arm straps; but *spinal instruments, with crutches, should never be used.*

For recumbency the prone position is better than the supine (see Chapter XI.)

Stafford, from having observed that in a military band the drummer was the most upright man, advised the use of a weight suspended from the shoulders to the abdomen. The muscles of the back are thereby exercised, and induced to keep the body upright, in order to counterbalance the anterior weight; but, in the majority of cases of excurvation, such treatment would be likely to cause the spine to give way laterally, in consequence of weakness of the muscles.

Well-regulated gymnastic exercises are very beneficial, but should never be prolonged sufficiently to cause fatigue.

Local stimulant embrocations, cold-water bathing, and a generally tonic plan of treatment, should also be adopted.

For further remarks upon the mode of exercising the spine, see under Treatment of Lateral Curvature.

Incurvation of the Spine.

Synonyms—Latin, *Lordosis*; French, *Lordose*; German, *Lordosis.*

The spine is curved forwards in this affection. It most commonly affects the lumbar region by an increase of the natural curve; but it may occur in the dorsal, and even in the cervical region.[1]

It may occur 1. In *rickets,* from depression of the pelvis, the increase of the lumbar curve being produced in order to maintain the equilibrium of the body.

2. As an effect of congenital dislocation of the hips.

3. As a compensatory curve in caries of the vertebræ.

[1] See specimens in St. Thomas's Hospital Museum, E. 20 and E. 22.

4. From paralysis of the abdominal muscles, or of some of the spinal muscles (Duchenne).

5. From ankylosis of the hip, the thigh being flexed.

6. From contraction of the psoas muscles.

Contraction of the Psoas Muscles may arise from—

1. Spasmodic action.

2. Long-continued repose in the contracted position.

3. Inflammatory changes in and around the muscles.

The causes of muscular contraction have been discussed in Chapter I.

FIG. 80.

A severe case of Incurvation from Contracted Psoas Muscles. (From a model of a case treated by Mr. Chance at the City Orthopædic Hospital)

As an example of the first variety may be mentioned the contraction which takes place in hip-joint disease.

An example of the second is seen in cases of long illness from some painful affection of the abdominal organs, in which the patient has remained for a long time in the recumbent position, with the thighs flexed upon the abdomen; and the third is sometimes seen as a result of psoas abscess.

Cases are sometimes met with in which the remote cause is not apparent, and in which contraction of the muscle or muscles is the only obvious condition.

Incurvation occurring in the dorsal region is referred to by Mr. Adams as a symptom sometimes of rotation of the vertebræ. As a compensating curve in caries incurvation may occur in any region of the spine.

Treatment.—The treatment will depend upon the cause; but, as a controlling apparatus, that recommended for the treatment of hip joint disease is the best that can be employed for contraction of the psoas muscles.

Lateral Curvature of the Spine.

Synonyms—*Scoliosis*; French, *Scoliose*; German, *Skoliosis* or *Rückgratsverbeugung*; Italian, *Scoliosi*; Spanish, *Escoliosis.*

Description.—This deformity consists in a lateral deviation of a portion or the whole of the vertebral column and rotation of the deflected vertebræ upon their vertical axes, so that their bodies turn in the direction of the convexity of the curve, and their spinous processes in the direction of the concavity.

The exact position and degree of the curvatures vary in different cases. There are usually two curves, and as one is compensatory to the other, it naturally forms in an opposite direction, producing a sigmoid appearance of the vertebral column, as shown in the figure.

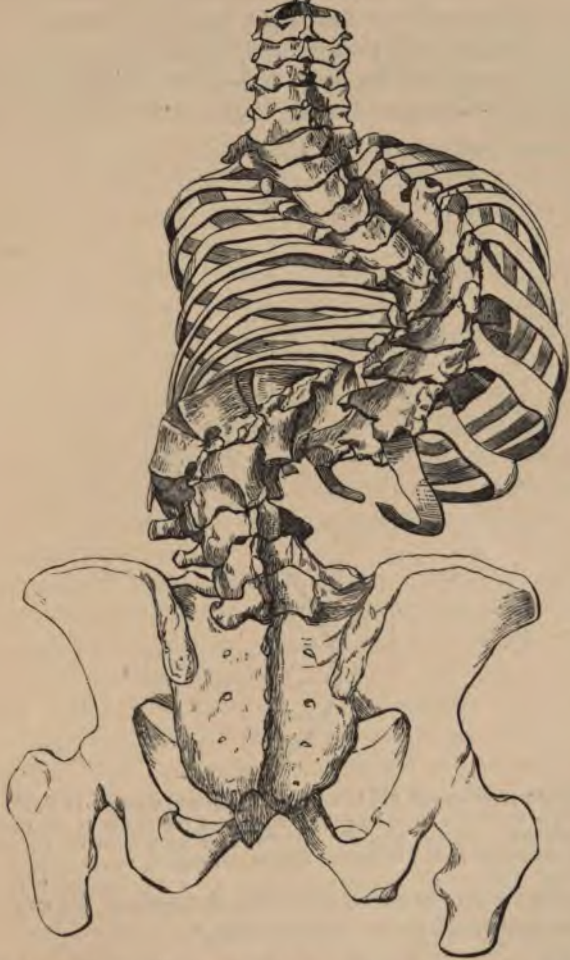
There may be but one curve, or there may be more than two curves. When the dorsal curve is lower than usual, there will perhaps be a compensatory curve in the cervical and upper dorsal regions, as well as in the lumbar; and even the sacrum is sometimes affected.

The deformity usually consists in a long arc in the dorsal and a short one in the lumbar region.

The convexity of the former is directed generally to the right, and the convexity of the latter consequently to the left. The curves, however, may form in the opposite direction.

At the Royal Orthopædic Hospital, out of 569 cases, in 470 the dorsal curve was to the right, and in 99 to the left, or about five of the former to one of the latter.

Fig. 81.

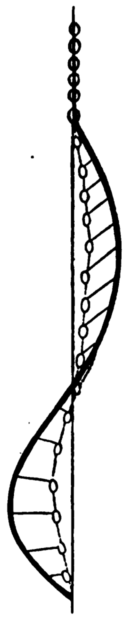


Skeleton of a Severe Case of Lateral Curvature. The rotation is well shown. (Copied from M. Bouvier's atlas, 'Déviations de la Colonne Vertébrale. Leçons Cliniques sur les Maladies Chroniques de l'Appareil Locomoteur.')

Bouvier found them in the proportion of seven to one.

The bodies of the vertebræ rotate upon an axis, so that the spinous processes have a direction towards the concavity of the curve. Consequently the apices of the spinous processes do not indicate the extent of the curvature[1]—a fact which is well shown by Mr. A. Shaw in the following diagram, showing that in severe

FIG. 82.



The bold outer curved line is intended to show the course of the bodies of the vertebræ; the faint dotted one that of the apices of the spinous processes. (Copied from Mr. Shaw's paper upon 'Lateral Curvature of the Spine' in Mr. Holmes's 'System of Surgery,' vol. v. p. 859.)

cases the transverse processes in the direction of the convexity project more than the spinous processes.[2]

[1] See case recorded by Adams in the *Transactions of the Medical and Chirurgical Society*, vol. xxxvii. 1854.

[2] See a paper by Jules Guérin, *Bulletin de l'Académie de Médecin*, March 1879.

The cause of this rotation has been explained in different ways.[1]

By some it is supposed to occur in consequence of the oblique form of the articular processes, which are brought into action more upon the concave than upon the opposite side of the curve.[2]

Others have considered rotation to be the consequence of the *serratus magnus* muscle acting upon the ribs as upon levers, the fulcrum of each rib being the transverse process of the corresponding vertebra.

The latter hypothesis might be disproved in many ways; but one will suffice, viz. rotation occurs as completely in the lumbar, where there are no ribs, as it does in the dorsal region.

Another theory is that of Dr. Judson, an American surgeon. It is based upon the fact that the posterior portion of the spine is a part of the parietes, and is thus more or less confined to the median line; whereas the bodies of the vertebræ project into the cavities of the chest and abdomen, and are free to move to the right or left.

Dr. Judson illustrates his theory by placing a brass rod, having only lateral movement, through the canal of a spinal column, and attaching the spinous processes by elastic cords to a framework, as shown below.

'To produce lateral curvature of the column, with rotation of the vertebræ, the knob at the summit of the rod is to be depressed. Double curvature, with rotation in each curve, may be produced by confining one of the dorsal vertebræ with the silk check loops, and depressing the knob.'

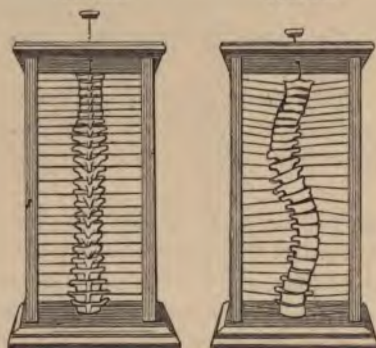
[1] Dr. Dick read a paper upon this subject, August 1864, before the British Medical Association, attributing rotation to mechanical laws.

[2] Herman Meyer (quoted from Bauer 'Die Mechanik der Scoliosis,' *Virchow's Archiv*, vol. 35) opposed this theory upon the grounds that (1) the articular processes have no definite or prescribed range of motion; (2) spinal tortion may be met with in all parts of the vertebral column, although the oblique processes differ in shape and position; (3) tortion prevails at an age when the oblique processes are not fully developed.

The supposed absence of rotation in lateral curvature, the result of pulmonary and pleural disease, Dr. Judson accounts for by the fact that the parietes on the concave side collapse, and the muscles and aponeuroses attached to the spinous processes upon that side consequently become relaxed.

In the few cases of lateral curvature, the effect of thoracic

FIG. 83. FIG. 84.



disease, examined by the writer, there was, however, distinct rotation of the vertebræ.

Mr. W. Hayward[1] attributes rotation to the unopposed action of the erectores spinæ muscles upon the convex side pulling the ribs and the transverse processes backwards; but even if we could believe that such an effect were likely to be produced in the dorsal region, it could not occur in the lower lumbar region.

Dr. Judson's theory appears to the author the most reasonable one.

Rotation produces a curved, rounded swelling upon the convex side, and the transverse processes may project to such an extent that they may be mistaken for the spinous processes, which are proportionately depressed.

In severe cases the rotation of the vertebræ in the dorsal

[1] *A Treatise on Orthopædic Surgery*, London, 1881.

region causes the ribs to protrude outwards and backwards to a very great extent; and a defined angle may be produced rather than a curve.

In the lumbar region the projection of the transverse processes has presented an appearance which has been mistaken, Mr. A. Shaw says, for an abscess or a morbid growth.

One effect of rotation is the obliteration of the natural curves of the spine.

In lateral curvature the height is lessened, unless the growth of a child outruns the progress of the deformity.

The thickness of the lumbar muscles, and the forward arch of this portion of the column, render the lumbar curve less distinguishable than the dorsal; but a fulness upon the convex and a depression, often a fold, upon the concave side may generally be recognised.

The lumbar vertebræ may be curved close to the brim of the pelvis, so that the 'waist,' if so it may be called, is raised on one side to a level with the ninth or eighth rib, while upon the other side it is represented by a deep hollow, causing an appearance of unnatural projection of the pelvis.

Morbid Changes in the Cartilages and Bones.

In consequence of the prolonged excessive pressure upon one side of the vertebræ, the bodies of the vertebræ, and also the intervertebral cartilages, become lessened by absorption and compression upon the side of the concavity. A wedge-shaped form is thus given both to the cartilages and the bodies of the vertebræ.[1]

The articular processes, which readily give way to pressure in a young subject, are also altered in form.[2] The articular surfaces, which in the lumbar region are naturally vertical, become oblique from pressure.[3]

[1] The bone is usually more compact upon the lessened side of the vertebræ.

[2] See Adams, *Transactions of the Pathological Society*, vol. iii.

[3] See A. Shaw, *Med. Chir. Trans.* vol. xvii. 1832, p. 466.

This absorption of bone and cartilage is probably one of the first, or *is* the first morbid change which occurs in lateral curvature.

Displacement of the ribs occurs to a greater or less extent in every case of lateral curvature. The heads of the ribs are brought nearer together upon the concave side, and are separated farther apart upon the convex side; and, moreover, the direction of their axes is convergent at the concavity, and divergent at the convexity, so that the arcs of the ribs are abnormally near to one another upon the one side, and abnormally separated from one another upon the other. Notwithstanding this alteration, it is very rare for any compression of the nerves proceeding from the spinal foramina to take place.

The ribs are sometimes stunted in growth on the concave side.

The backward protrusion of the ribs upon the convex side of the dorsal curve, and the backward bulging of the transverse processes and muscles on the convex side of the lumbar curve, is the natural result of rotation of the vertebræ, and is well shown by the diagrams on the opposite page, copied from the article upon 'Lateral Curvature,' by Mr. Shaw, in Mr. Holmes's 'System of Surgery,' 2nd edition.

These figures show that the front of the body, although not quite so much deformed as the back, is yet considerably influenced by the rotation. The figures also show that the thoracic cavity is compressed chiefly upon the side to which the curve is directed.

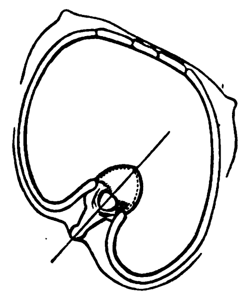
The right scapula (if the dorsal curve projects to the right) is raised above its ordinary level, and projects backwards, and in consequence of the thorax upon this side being less flat than is natural, the posterior border may be raised from the ribs, and the trapezius muscle is sometimes very prominent.

On the left side the upper part of the thorax being more or less flattened, the scapula, and with it the whole shoulder, falls downwards and away from the ribs.

In some severe cases the posterior parts of the ribs on the convex side are so bent, and the thorax consequently so collapsed, that the shoulder on this side also falls.

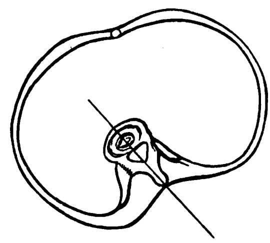
All the above-mentioned external symptoms of lateral curvature are more marked, when one of the curves is greater than the other, than when they are equal in extent. For in

FIG. 85.



Supposed transverse section of the Thorax about its middle: to show the Displacement of the Ribs consequent on the Contortion of the Dorsal Vertebræ. (After A. Shaw.)

FIG. 86.



Supposed transverse section of the Abdomen at the Lumbar Region. (After A. Shaw.)

the latter case, the shoulders may be nearly level. As the tendency of this affection is to increase continually, unless relieved, the deformity may become so severe that very serious results may occur from pressure upon the thoracic or abdominal viscera; and a case is recorded in which partial excision of one of the clavicles had to be performed in order to avert suffocation from pressure upon the trachea. The cavities of the thorax and abdomen are so much altered in shape by the deformity, that the viscera become displaced and changed in form to an extraordinary degree.

The lungs, heart, liver, kidneys, uterus, and bladder may suffer more or less from compression in bad cases, but the stomach and intestines accommodate themselves to their altered positions. The curves of the spine soon become so fixed that extension and counter-extension produce no visible change in them. Nor will they be altered by the patient leaning sideways.

Lateral curvature commences most frequently at about the period of puberty, between the tenth and sixteenth years of age, but it frequently occurs at later or earlier periods of life. A. Shaw gives the age of fourteen as that of the majority of cases—an age when the bones are very incompletely ossified.

The affection occurs much more frequently in girls than in boys; and out of 173 cases recorded by Lonsdale and Adams, 151 were females and only 22 were males.

Sir Charles Bell[1] observed, 'Upon the whole, then, the effect of the lateral or sigmoid distortion is to produce an ungainly walk, to curtail the girl of her natural stature, to disfigure the bust, or neck and shoulder, and to push out the left breast. But more, if permitted to increase (and it is of a nature to increase when once the bias is given), the capacity of the chest is diminished, and the lungs compressed, with consequent injury to the general health.'

'Obliquity of the pelvis is supposed,' Mr. Adams says, 'to exist much more frequently in cases of lateral curvature than it really does; and the deceptive condition which most frequently leads to this supposition is a prominence, or, as it is called, "a growing out," of one hip . . . . caused by the receding of the muscles in the concavity of the lumbar curve.'

In the young, not only are the vertebræ semi-cartilaginous, but the joints are also very flexible; therefore, when curves are once formed, they increase the more rapidly the younger the

[1] *Practical Essays*, Edinburgh, 1842, p. 125.

patient. At the same time, the more flexible the column the more amenable is the case to treatment.

For these reasons early treatment is imperatively called for. While the affection remains untreated, absorption of the compressed parts of the skeleton continues to progress.

Diagnosis.—The possibility of lateral deformity of the spine being dependent upon caries must lead the surgeon to exercise great care in making a diagnosis in doubtful cases. No exact rules can be laid down, but all the symptoms must be taken into consideration.

In young children great weakness of the back may be present, which, in the positions of sitting or standing, allows the spine to bend in various directions, forming at one time an excurvation and at another one or more lateral curves. Although this condition would probably lead eventually to the formation of lateral curvature, yet in diagnosis a distinction is to be drawn, for when this condition of weakness exists support to the back and rest are more important at first than exercise. In fact, in severe cases, the strength of the child is more rapidly and safely restored by absolute rest, at first, than by attempt to exercise the muscles. These curves are readily movable in any direction : the spine can be easily straightened or bent.

As lateral deflexion of the bodies of the vertebræ usually exist to a greater extent than the deflexion of the spinous processes, and the former displacement precedes the latter, it follows that the early stages of the distortion may be difficult to diagnose. Adams alludes to the flattening of the back which is sometimes present in cases of shoulder projection, unaccompanied by any lateral deviation of the spinous processes ;[1] but, upon the other hand, excurvation often precedes and accompanies the deformity under consideration.

As the position of the spinous processes does not indicate the position of the bodies of the vertebræ, the diagnosis of lateral curvature must not depend alone upon an examination

[1] See record of the case of Dr. Mantell in *Med. Chir. Trans.* vol. xxxvii.

of these processes. It is upon the posterior prominence of the angles of the ribs upon one side and their depression upon the other side that curvature in the dorsal region is to be detected, and upon the posterior prominence of the apices of the transverse processes on one side and their depression on the other side that curvature in the lumbar region is to be diagnosed.

The other symptoms already detailed will, also, of course guide the surgeon in forming an opinion as to the nature of the case.

In stooping, the distortion of the ribs is made much more apparent, the prominence being increased upon the one side and the depression being rendered more distinct upon the other.

Hysteria.—There is a class of cases in which there is an apparent inability to control the muscles of the back, associated with general so-called hysterical symptoms. The curves are not fixed; the patient can be placed in a normal position, but when left to herself immediately relapses to one or other side, and the back becomes again curved laterally. These cases are easily recognised.

Nervous mimicry may assume other symptoms of lateral curvature, and Sir James Paget,[1] in discussing these cases, remarks, 'The curvatures of the spine that occur frequently in young persons are often painless, are seldom very painful, and have no characteristic pain; yet pain of any kind should always lead you to examine for curvature, and to suspect, if there be curvature already, that it is increasing.'

Hysterical curve may be formed very quickly, and be apparently fixed, but if the patient stoops low enough to touch the ground with the hands, the back becomes normal in shape, which is not the case in real curvature.

It is seldom, if ever, necessary to give an anæsthetic for the purpose of diagnosis, but under such influence severe curves that would be fixed in real curvature disappear if they depend entirely upon hysteria, but it must be remembered that hysteria may accompany real lateral curvature.

[1] *Clinical Lectures*, 2nd edit. edited by Howard Marsh, 1879.

Prognosis.—Presuming that all the causes can be removed, the prognosis depends upon—

1. *The Age of the Patient.*

If the case occurs in infancy or early childhood (Mr. Adams says under twelve) the prognosis must be guarded, as the distortion is often associated with extreme debility or with some constitutional disease, and under the most favourable circumstances the treatment is then generally tedious. Cases commencing between twelve and fifteen years of age are the most favourable for treatment; and some of these cases may recover even if left to themselves. But a spontaneous cure is very uncertain, and, if depended upon, the deformity is likely to increase very insidiously, and assume a permanent character, before treatment is considered necessary.

There is no age at which the deformity can be said to cease liability to increase, i.e. if no means are adopted to restrain the progress of the affection.

2. *The Duration of the Deformity.*

No absolute rule can be laid down for forming a prognosis as to the possibility of cure or relief, with regard to the time the deformity has existed, but, generally, the longer the affection has been present the more unfavourable the prognosis.

Theories upon the Origin of Lateral Curvature.

Delpech attributed lateral curvature to a disturbance of the antagonism between the muscles of the two sides of the back: he believed that every muscle has its antagonist, and that certain groups of muscles are equally balanced by opposing groups, and that absence of lateral curvature depends upon the equal power of both sets of muscles.

If this theory be correct, it naturally follows, as Delpech argued, that increase or decrease of muscular power upon one side of the body would give rise to lateral distortion.

Bauer refers to Dr. Werner,[1] who opposed the theory of

[1] *Reform der Orthopædie*, Berlin, 1851.

muscular antagonism, because the muscular development upon the two sides of the body are so seldom equal.

Borcelli, also, seems to have written to the same effect.

In opposition to Werner's view, and in support of Delpech's theory, it is often urged that occupations necessitating greater use of one arm than the other give rise to spinal deflexion. But this supposition is to a great extent an error, *faulty position* generally accompanying the excessive use of one or other arm, and being the cause of the deformity.

Jules Guérin advanced the theory of 'muscular retraction,' which he considered the sole cause of lateral curvature. He advocated and practised tenotomy and myotomy in all cases of lateral curvature, and published many cases which he claimed to have cured.

Considerable sensation was thus caused among the Parisian surgeons, some of whom adopted his theory and treatment. Others, among whom were Diffenbach and Malgaine, opposed the treatment recommended by Guérin.

A committee of enquiry into the subject was appointed by the Academy, and, according to Bauer, they collected twenty cases. 'Most of them were not only aggravated by the operation, but some completely disqualified to labour.'[1]

Stromeyer advanced a theory of one-sided paralysis of the respiratory muscles, which has not met with much favour.

There are few supporters in the present day of the 'muscular contraction' theory, and, as Bampfield[2] pointed out many years ago, the condition of the muscles upon the two sides of the body is not in accordance with such a view. The condition of the muscles is usually one of flaccidity upon the concave side from partial disuse, and increased development upon the convex side of a curve from muscular endeavour to keep the spine from bending farther.

[1] Adams and Tamplin tried the effect of Guérin's treatment, but were dissatisfied with the results.

[2] *Essay on Curvatures and Diseases of the Spine*, London, 1824.

These remarks refer to the formation of the primary curve, the compensating curves being formed by muscular action.

Mr. John Shaw found, upon dissection, that the muscles had atrophied upon the concave side, and he also found the nerves that supplied these muscles 'diminished to less than one-half their natural size'—a condition which he supposed depended upon the atrophied condition of the muscles.

Mr. Gay[1] dissected a case of severe lateral curvature in the cervical and upper dorsal vertebræ, convex to the left, in a young woman aged 23, who died from fever. The muscles of the chest, both before and behind, were very feebly developed and pale. 'The intercostals of the left side had lost the usual characteristics of muscular tissue'—were degenerated to a mere membranous expansion. The sacro-lumbales and longissimus dorsi on both sides were 'comparatively large and powerful.' The abdominal muscles were large, but partook of 'the general feebleness of the integral structure.' The diaphragm was very powerful. Attempts to straighten the spine at this stage of the dissection caused the lumbar fascia to become tense and resistant. That fascia, being divided transversely, extension caused only a separation of the cut fibres, to the extent of half an inch. Although all the muscles were removed, no manual force could straighten the spine. The intervertebral fibro-cartilages were thinned on the concave and thickened upon the convex side of the spine; their elasticity was lost.

Mr. Gay refers to preparations in Guy's Hospital, and to dissections published by M. Bouvier, as other examples of somewhat similar conditions.

Lateral curvature of the spinal column was at one time attributed to primary disease in the bones and intervertebral cartilages; and even in modern times Lorinser has stated[2] that this affection is caused by an osteomyelitis. The condition of the bones in lateral curvature is referred to below.

It would be tedious and unprofitable to discuss all the

[1] *Lond. Med. Gazette*, Dec. 1841.

[2] See Bauer, *Lectures on Orthopædic Surgery*, New York, 1868.

speculative theories that have been advanced with regard to the causation of lateral curvature, but there seems abundant evidence to prove that some debility exists as a predisposing, and that certain habits or circumstances act as exciting causes.

Causes of Lateral Curvature.

These may be divided into *predisposing* and *exciting* causes.

The exciting causes may give rise to the affection when the predisposing causes do not exist, and the predisposing, if severe, will allow the formation of curvature, although the exciting causes are so slight that they are scarcely, if at all, distinguishable, or possibly are not present.

The predisposing causes are probably all circumstances which give rise to debility. This debility may act generally, or it may affect the dorsal muscles, and disenable them to retain the spine in an upright position for long periods.

The condition of the bones may predispose to the rapid formation of curves, supposing always that more pressure is allowed to bear upon one side of the spine than upon the other side.

1. In rickets the vertebræ readily give way to lateral pressure.

2. When a child suffers from general debility, and especially when the so-called scrofulous diathesis is present, the bones are probably more readily influenced than they are in health.

3. When a child is growing rapidly curves are naturally sooner formed than when growth is slow.

We find the affection more common among the rich than among the poor, more in cities and towns than in the country.

We have seen that it occurs most frequently in girls, and at about the time of puberty, and it is very common to find some retardation of sexual development or some derangement of the commencing menstruation.

Insufficient exercise and confinement predispose to lateral curvature, especially in children who are growing rapidly, 'and whose spines,' as Bauer has remarked, 'are endowed with an unusual degree of flexibility.'

When boys are affected with this deformity, they are often found to be effeminate in their conformation, 'possessing very flexible spines.'

At the time of puberty in the female the vital powers are directed so specially to the development of the sexual organs, at the expense possibly of other parts of the body, that the dorsal muscles are very likely to become weak.

Improper diet, sedentary habits, violent dancing, and 'late hours' have been adduced as predisposing causes; and we may add that all habits and circumstances which depress the bodily health may act as such, and especially those in which the muscles of the back are overtaxed, or in which their development is retarded.

In some families there is an hereditary tendency to lateral curvature, which perhaps indicates hereditary weakness, and when stiff corsets are used by growing girls, the full development of the dorsal muscles is seriously interfered with, and weakness of the back is the natural consequence.

The influence of stays in producing local muscular debility has been variously estimated by authors. Of course in very young children stays are not worn, and therefore cannot be a cause, but, at the time of puberty, when this deformity most frequently commences, the majority of girls wear stays, which must retard the development of the dorsal muscles.

Mr. Adams considers that the cases which occur before the age of five are probably hereditary. Those between the ages of seven and twelve sometimes have a history of hereditary tendency, and 'the constitutional cause seems to consist in a strumous diathesis.' Those between twelve and sixteen years of age depend, that author considers, upon debility caused by too rapid growth.

The exciting causes are conditions which disturb mechanically the equilibrium of the spinal column, continuously or for long periods :—

1. *Inequality in length of the lower extremities*, either from original conformation or from disease or accident, causing obliquity of the pelvis.

2. *Inequality in the weight* of the two sides of the body, as occurs, for instance, when an arm has been lost.

3. Disease or injury, producing contraction of one side of the thorax or abdomen, such as empyema.

4. Alteration in the position of the head, as when wry-neck occurs.

5. Bad habits of position (sometimes the result of the predisposing causes).

The following are some of these bad habits of position.

Some Bad Habits of Position.

1. Standing upon one leg, the right being usually selected.

2. A great deal of horse exercise without the use of a reversible saddle.

3. Sitting at too low a table for writing, so that the body is leant over upon the left arm.

4. Bad positions of sitting at various employments, such as drawing and painting.

5. Bad positions during ironing, nursing, &c., such as carrying a child frequently upon the same arm.

6. Sleeping always upon one side, with the head resting upon too high a pillow.

7. Carrying heavy weights.

8. Fatiguing attitudes, such as standing in school, sitting upon stools or forms without backs.

With regard to *inequality in the length of the lower limbs*, it seems that such a condition exists much more often than was formerly believed. The researches of Drs. Hunt,[1] Cox,[2] Wight,[3] and Roberts[4] in America, and of Dr. Garson[5] in

[1] *Philadelphia Med. Times*, Jan. 1875.

[2] *American Journal of Med. Sci.* April 1875.

[3] *Arch. Clin. Surg.* Feb. 1877, and *Procds. Med. Soc., County of Kings*, Jan. 1878.

[4] *Phil. Med. Times*, Aug. 1878.

[5] *Journal of Anat. and Phys.* July 1879.

London, show that equality in length of the lower limbs is an exceptional condition.

In fifty-four persons examined by Dr. Cox, only six possessed limbs of equal length—the variations ranging from $\frac{1}{8}$th to $\frac{7}{8}$th of an inch.

Dr. Wight, of Brooklyn, examined 102 individuals, only twenty-three of whom possessed an equal length of leg. The average difference in length was $\frac{1}{4}$th of an inch.

The majority of the American measurements were made upon the living subject. Dr. Roberts, however, examined eight skeletons, in only one of which were the limbs of equal length.

Dr. Garson carefully measured seventy skeletons at the Royal College of Surgeons, and his experiments have been made doubly valuable by being observed and revised by Professor Flower.

In only 10 per cent. of these cases were the limbs equal in length.

The left limb was found longer than the right in thirty-eight cases (54·3 per cent.) The right was the longest in twenty-five cases (35·8 per cent.) The amount of inequality varied from 1 to 13 mm. (i.e. from about $\frac{1}{25}$th to about half an inch).

In only thirteen of these seventy did the inequality amount to 6 mm. (about $\frac{1}{4}$ in.) or over; so that, in the majority, the effect upon the equilibrium of the spine would be very slight. Moreover, slight inequalities in the femora and tibiæ might be compensated for by slight differences in the pelvis and feet.

To what extent these irregularities may be dependent on or independent of any morbid processes which may occur during the period of development and growth, the writer is not prepared to discuss, but he may remark that a large number of cases occur in which temporary arrest of development has caused one leg and foot to be smaller in all proportions to the other leg and foot.

This condition has been mentioned in the chapter upon

Club-foot, the two affections being frequently co-existent, and for the reasons there stated.

Besides the causes of arrest of development already considered, there may be arrest of growth of the long bones, from injury to one or other of the epiphyses.

Besides arrest of development, there are many other ways in which one limb may become shorter than the other, such as from a destruction of parts from joint disease, shortening from fractures, bending from rickets, or flat-foot.

FIG. 87.

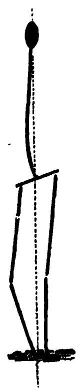


Diagram to show the position of the Spine when the individual is standing upon one leg.

FIG. 88.

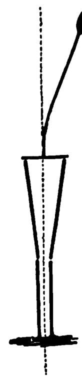


Diagram to show the position the Spine would assume (the legs being straight) if the Lumbar Curve remained fixed.

FIG. 89.

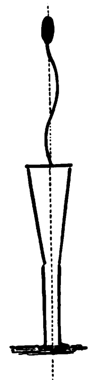


Diagram to show the Dorsal Curve formed by the efforts of the patient to maintain the equilibrium of the body.

Formation of the Curves.—Many observers consider that the lumbar curve is first formed. Mr. Alexander Shaw is of this opinion, and he believes that the habit of standing upon one leg, 'standing at ease,' is one of the most frequent exciting causes.

In a young person possessing flexible joints a large sweeping curve is produced, extending from the lower part of the dorsal region to the sacrum.' 'Standing at ease' relieves the fatigued muscles, and in young, growing people, especially if they are not strong, the curve is likely to become permanent. While the body is supported in its oblique position, no inconvenience is experienced; but when the individual ceases to hold the pelvis obliquely, and sits or walks, the body will be bent over to the opposite side.

But as the equilibrium must be restored, and as muscular effort cannot so easily overcome the curve already formed as it can produce a new and compensating curve, the muscles upon the convex side of the primary curve act upon the upper part of the spine, and by gradually raising it, and drawing it towards the median line, bring the head into the line of the centre of gravity, thus forming a dorsal compensating curve.[1]

Several alternate curves may thus be produced; but the primary curve may be either lumbar, dorsal, or cervical, according to the cause. Obliquity of the pelvis produces a lumbar curve first. Wry-neck will give rise to cervical curve, and frequent obliquity of the shoulders will cause the primary curve to appear in the dorsal region. The principles of the formation of curves as shown in the foregoing diagrams apply to all these cases.

When the curves are once formed, the tendency to increase is perhaps greater in the dorsal than in the lumbar region.

It is probable that all exciting causes act by disturbing the equilibrium of the spine; and, whether this condition be brought about by bad habits or by trade occupations, in all cases the dorsal curve is more commonly formed to the right.

If an individual stands upon one leg, the right is generally selected, causing a primary lumbar curve to the left and a compensatory dorsal curve to the right; and if habits or trade occupations cause obliquity of the shoulders, the right one will usually be that which is raised, and the left depressed, thus causing a primary dorsal curve to the right.

It has been already stated that the predisposing causes may alone, possibly, allow the formation of lateral curvature. The deformity is produced in such cases probably from an

[1] See A. Shaw in Holmes's *System of Surgery*, vol. v.

attempt upon the part of the patient to maintain the spine in an upright position with as little muscular exertion as possible.

If the standing attitude is assumed for long the dorsal muscles become fatigued, and the spine is allowed to 'subside' as much as possible consistent with the balance being maintained. Standing upon one leg is usually assumed for the purpose of allowing this 'subsidence;' and we have already discussed the formation of curves under such circumstances. But the fatigue of the muscles may be partially relieved by the individual allowing the spine to bend, independently of standing upon one leg; and in sitting upon a form the spine is allowed to curve in this manner.

Some of the more frequent Functional Derangements caused by Lateral Curvature.

1. Interference with the thoracic viscera.
   Palpitations.
   Faintness.
   Impeded respiration.
2. Interference with the abdominal viscera.
   Nausea.
   Indigestion.
   Hepatic disorders.
3. Interference with the pelvic viscera,
   General symptoms of bad health.
   Pain in the region of the spine, spasmodic pains.

Treatment.

In the first place the causes must be removed.

If the curvature has arisen from obliquity of the pelvis, the cause of that obliquity must be dealt with. This generally depends upon inequality in the length of the legs; and some means must be adopted to restore the pelvis to its normal position. All fatiguing attitudes and occupations (see Exciting Causes) must be forbidden.

The general health of the patient must be treated. There may be ill-health, the result of the curvature, or the result of the debility which has been present before the curvature took place.

Curvature, associated with or the result of rachitis, must be treated for the constitutional disorder, as well as for the spinal deformity (see Rachitis).

Special Treatment.—The special means of treatment which we have to consider are—

1. *Local Stimulants.*
2. *Rest.*
3. *Muscular Exercises.*
4. *Mechanical Extension.*
5. *Mechanical Support and Pressure.*

The consideration in this place of myotomy and tenotomy is purposely omitted, because such treatment has been proved to be totally unsuited to lateral curvature of the spine.

1. *Local Stimulants.*—Friction with simple or stimulating liniments, and cold douches, have been found useful in giving tone to the muscles of the back. Warm-water bathing has been recommended, and will be beneficial sometimes if followed by a cold douche.

Muscle beating and kneading may also do good as local stimulants.

2. *Rest.*—Absolute recumbency, i.e. lying down for perhaps one or two years, has had many advocates. Such exclusive and severe treatment is injurious to the general health, and has not been found to cure any but the slightest cases of this affection.

Partial recumbency, however, when combined with other treatment, will always be beneficial in its effects, especially in rapidly growing children.

Fatigue is to be carefully avoided. The patient should lie down directly the upright position of the back cannot be maintained with perfect comfort. The couch used should be well stuffed, and so made that the attitude of the patient need not be constrained.

The position assumed during the recumbency should be that which affords the most complete rest to the muscles of the back, while the vertebræ and intervertebral substances are relieved from the pressure of superincumbent weight. Chairs which fit into the natural curves of the back afford much more relief than ordinary chairs; but the pressure referred to is not thus relieved.

The supine position, with a small pillow in the lumbar region, may be adopted; but the prone position possesses certain advantages over all others.

A couch should be used, made horizontal beneath the thorax, and slanting slightly from the pelvis towards the feet.

Fig. 90.

(After Adams.)

The arms can be used freely in this position, such use tending to straighten the back and to exercise the dorsal muscles; but the supine position tends to weaken the back and produce 'roundness of the shoulders' (excurvation).

Hard back-boards should never be employed. Adams considers that recumbency is particularly useful when the curvature predominates in the lumbar region, as in that part of the back mechanical support is less effective than in the dorsal region.

3. *Muscular Exercises* are employed for two purposes—

1. To strengthen weak muscles.
2. To act directly upon the curves.

For the purpose of giving strength to the dorsal and thoracic muscles, and of improving the general health of the individual, the exercises should be so directed that all the muscles of the back should be equally brought into action.

Exercises may be employed in the standing, sitting, or recumbent positions.

Of the many varieties of exercises which are beneficial, the following may be noted:—

The patient, sitting upon the front edge of a chair, should exercise the back by means of an elastic cord attached to a fixed point in front of him. The cord should be held by the hands close to the shoulders, and the body bent backwards and forwards.

Various swinging exercises upon a trapeze; exercises upon parallel bars; or the use of very light dumb-bells may be advised.

Whatever kind of exercise is adopted, it should never be allowed to produce fatigue; and a suitable couch should be used by the patient to rest upon.

As a preventive measure, swimming is an excellent means of exercising the dorsal muscles. But, as a curative means, the requisite expenditure of muscular power is too great.

In slight cases of lateral curvature, in which muscular debility has been the predisposing cause, well-regulated muscular exercises will be highly beneficial; but they will do little or nothing to remove curves which have become fixed.

Muscular Exercises to act directly upon the Curves.—Gymnastics have been devised for this purpose, but none that the author has seen or read of are based upon sound anatomical principles. One method which has been advised is as follows:—The patient swings upon two horizontal trapeze-bars, one hand upon each; the hand of the arm upon the concave side of the dorsal curve is placed higher than the other, with the object of bringing into use the muscles in the concavity. Now the muscles which extend from the arm to the concavity are the rhomboidei, the trapezius, and the upper part of the latissimus dorsi, and these are attached to the *spinous processes* of the vertebræ. The spinous processes are directed towards or into the concavity of the curve, and therefore the above exercise tends rather to increase the rotation of the vertebræ and is thus not beneficial to the patient.

The *latissimus dorsi* extends to the spinous processes of the lumbar vertebræ also, so that action of this muscle might theoretically have some slight beneficial effect upon the lumbar curve; but, practically, the effect would be slight.

4. *Mechanical Extension.*—This means of treatment has a very ancient origin, and has been employed chiefly upon the following principles:—

The patient lies upon a couch, the head is fixed by a collar, or by lateral support attached to the couch, and extension is made by springs or by weights from the pelvis. Sometimes (as in Cole's sofa) the patient lies in a prone position, and grasps a bar at the upper end of the couch, whilst extension is made from the pelvis by a belt, cords, and winch. Many of these extension couches are fitted with an apparatus intended to cause direct pressure upon the curves. This purpose is attempted in Buehring's couch by fixing the waist in a belt attached to the couch, and then applying pads to the convexities of the two curves. The pads are worked by lateral screws. Many couches have been constructed which attempt to redress the curves by two belts, each pulling against the individual convexities by springs attached to the sides of the couch. The 'corset-lit' of Valerius resembles in appearance a gigantic lobster-shell. A case for the head, another for the thorax, a third for the lumbar region, and a fourth for the pelvis, move one upon another, and are regulated by apparatus attaching the whole machine to a table.

Tuson invented a couch which provided means for exercises as well as for extension. The muscles of the trunk generally were exercised by this machine.

Extension by means of suspension was, according to Humbert, first employed by Glisson in 1580. He used to suspend children by the head and arms in such a manner that the weight of the individual, sometimes augmented by weights attached to the feet, bore equally upon the three supports.[1]

In France and Germany this system of treatment has been very extensively employed.

In this country Mr. Stafford invented a suspending machine, by which the patient could be raised from the ground by the upper part of the body while the lower part remained suspended. Weights were attached to a belt. 'The muscles on the concave side are lengthened, while those on the convex are shortened and allowed to contract, whereby they are both put into a more favourable position to pull back and retain the vertebræ in their situation.'[2]

John Shaw employed an apparatus for relieving the back of some of its superincumbent weight while the patient was sitting in a chair for writing, drawing, &c.

Mr. Adams, writing in 1864, states that he had seen, in a private establishment for the treatment of deformities, 'a sort of hanging contrivance by which patients were drawn up by the head off the ground, and allowed to remain suspended in the air for a certain time;' and Sayre has introduced into this country[3] from America a plan of self-suspension, in combination with the application of a plaster of Paris jacket, originated by Dr. Benjamin Lee, of Philadelphia. Dr. Lee made his patients climb a rope which passed over a pulley, 'and was attached to the patient's head by straps, passing under the chin and occiput.'

Sayre writes, 'To a hook, at the upper portion of an iron tripod about ten feet in height, is suspended, by means of com-

[1] *Traité des Difformités du Système Osseux, ou de l'emploi des Moyens Mécaniques Gymnastiques dans le Traitement de ces Maladies.* Paris, 1834.

[2] *Two Essays on Diseases of the Spine.* R. A. Stafford, London, 1840, p. 76.

[3] *Spinal Disease and Spinal Curvature.* By Lewis A. Sayre, M.D., New York, 1877.

pound pulleys and tackle, the iron cross-bar' . . . . to which the patient is attached by the head and chin collar only, and not by axillary straps. The patient is to be taught to suspend himself by means of this apparatus, and be requested to take several deep and full inspirations during suspension. Great care is directed to be taken that *the hands be kept above the head*; so long as this is the case, the great thoracic muscles, as the pectoralis major, latissimus dorsi, serratus magnus, &c., are brought into play, and the ligaments of the neck are relieved of the greater part of the strain. If the hands be allowed to descend below the level of the head while the patient is self-suspended, there will be a risk of too much strain being thrown upon the ligaments of the neck, and of consequent serious damage. During the self-suspension some one should be at hand, especially if the patient be a child, to guard against accident from the twisting of the rope, and to see that the operation is properly conducted. When the patient has elevated the body to the highest point, and proposes to rest suspended for a time, the uppermost hand on the cord should always be that on the side of the concavity of the dorsal region.' While the patient is in this suspended position, Sayre recommends the application of a plaster of Paris jacket.

The result of self-extension and the plaster of Paris jacket in lateral curvature has not been satisfactory.

All the above plans of mechanical extension are very complicated; they are irksome or painful, and often dangerous to the patient; some of them might justly be called barbarous.

If improvement does not soon take place under general hygienic treatment, recourse should be had to some mechanical appliance, which, however, should be as light and simple as possible, and should not interfere with due exercise of the weak muscles.

5. *Mechanical Support and Pressure.*—Mechanical apparatuses, fitted to the patient's trunk, have been employed with a variety of objects, of which the following are the chief:—

1. To relieve the curves of the spine from some of the superincumbent weight.
2. To straighten the spine by direct or indirect pressure upon the abnormal curves.
3. To press upon the curves, and correct the rotation of the vertebræ.

Of the instruments which have hitherto been described, all those which are intended to fulfil Object 1 endeavour to do so by crutches, which take their basis of support from the pelvis.

Those which purpose to fulfil Objects 2 and 3 usually consist of the above framework, with an upright stem opposite to the spine, to which is attached lateral plates, which can be adjusted to the convexities of the curves.

Some instruments have two uprights, one plate being attached to each; but in both cases the upright bar or bars can be moved laterally and antero-posteriorly by means of rack joints at their junction with the pelvic band.

In some instruments the crutches are connected to a horizontal bar, which is attached to a single upright at the back. The effect of these crutches is the same as that produced by those already described.

Crutches are objectionable, for the following reasons:—

The arms being connected with the trunk but loosely, the attempt to prop up the superincumbent weight by raising the shoulders is necessarily unsatisfactory in its results. If the props are raised sufficiently to act mechanically, the pain from the extremely raised position of the arms would be very severe, until the nerves became paralysed—a result which has sometimes occurred. The circulation, moreover, would be interrupted.

Upon the other hand, if the crutches are only sufficiently high to be unproductive of the above evil effects, their use is limited to the occasions when the patient supports herself upon them voluntarily.

Another evil effect of the spinal instruments usually employed is that they tend to retard thoracic respiration, whereas it should be the object of the surgeon to encourage development of the thoracic cavity.

In *post-mortem* examinations of subjects affected with lateral curvature, the muscles of the thoracic walls have been much degenerated, and the diaphragm excessively developed. This condition was well marked in a case examined by Mr. John Gay,[1] showing that respiration had been chiefly diaphragmatic. The tendency of lateral curvature is to lessen the thoracic cavity, and, therefore, one important object of treatment should be to encourage the expansion of the thorax.

By means of some of these instruments continued pressure may be so brought to bear upon the curves by the side plates that some reduction may be effected; but at the same time the action of the dorsal muscles is interfered with, and so the weakness of the back is encouraged, and the natural cure is retarded.

When a spinal apparatus is necessary, it should be constructed and adapted upon the following principles:—

In *moderately severe cases*—

1. To allow freedom of action to all the muscles of the back, and, in fact, of the whole trunk.
2. To afford support to the back, in a good position, directly the muscles become fatigued.
3. To be light.
4. *To be adaptable by the surgeon himself.*
5. To encourage thoracic respiration.

In *more severe cases*—

In addition to the above objects, we must employ means to unfold the curves, or, when the case is so extreme and of such long standing that no improvement can be expected, we must give support to the body, and prevent further increase of the deformity.

The only apparatus which thoroughly fulfils the above-described objects is that invented by Mr. E. J. Chance, the good

[1] *Lond. Med. Gazette*, December 1841.

results of which have been shown among the patients of the City Orthopædic Hospital, as well as in patients treated by the author of this work. This apparatus is formed as follows:—A belt (A, fig. 91) surrounds the pelvis; a single upright rod (B) passes from this belt as high as the shoulders; a pad (C), movable by a key, is attached to the upright rod; shoulder straps proceed from this pad, as shown in the figure; an abdominal belt is attached by straps to a pad opposite the lumbar region,

Fig. 91.

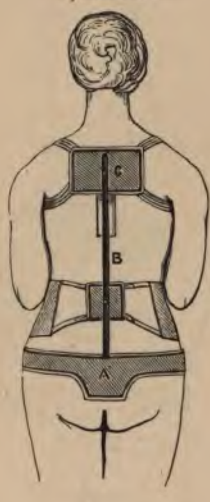


Fig. 92.

and this pad is fixed to the upright rod. The apparatus is so fitted that when the patient is seated the lower portion of the pelvic belt (A) comes in contact with the chair, so that the support in resting the back is complete.

In more severe cases lateral plates are fitted to the upright bar, which can be accurately adjusted to the curves. The plate upon the convex side of the dorsal curve is counterbalanced by the plate which is placed against the side of the thorax, beneath the arm of the opposite side. By this means the curve is unfolded in the direction indicated in fig. 93. The advantages of this instrument over others are—

1. Its simplicity.
2. The absence of crutches.
3. Its greater adaptability to alteration in form *by the surgeon himself.*
4. Its lightness.

FIG. 94.

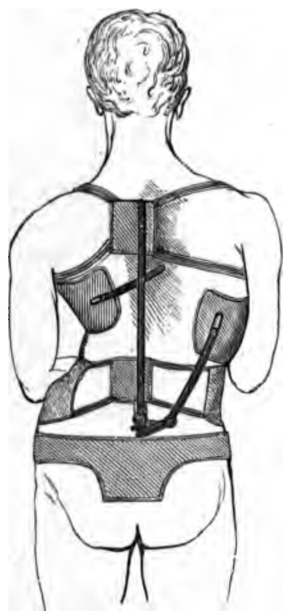
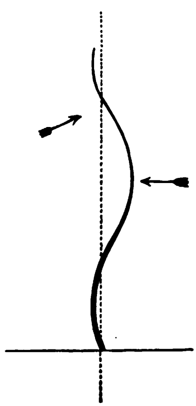


FIG. 93.



5. Its power of maintaining the spine in an upright position, without interference with muscular action, this result being obtained chiefly by the absence of the crutches, and by its acting without fitting into the lumbar curve.

In fact, by means of this apparatus a rest for the back is ready the moment the muscles become fatigued; and, moreover, the spine is thus rested in as upright a position as the curves will allow, and thus the patient has the advantages which would be obtained from resting in the most perfectly constructed chair, without the risk of ever allowing the spine to 'subside' without using the support.

In very severe cases a second movable upright may be necessary, as in fig. 94.

When an instrument is used, it should always be carefully adapted by the surgeon himself, and the pressure of the lateral plates should never be so great as to cause either pain or discomfort to the patient.

The most important point to be determined in treating a case of lateral curvature is with regard to the use of a spinal instrument. If a case is treated in the earlier stage the support may and should be dispensed with; but the objections which have been more or less justly raised against those apparatuses which interfere with all muscular action do not apply to the support here recommended.

Treatment without Instruments.

1. The back should be rubbed with a simple liniment, night and morning.

2. The patient should lie down on a soft and easy couch (a 'prone couch' is best), except when in active muscular employment.

3. Muscular exertion should never be continued long enough to produce fatigue.

4. Some of the special muscular exercises should be practised three or four times a day for short periods.

5. The dress should not be tight enough to interfere with free muscular action. Ordinary corsets are not to be worn; but if some stay is required to keep up the dress, it should be made of a soft and pliant material.

6. Especial attention should be paid to the habits of position of the patient.

School life often doubtless assists materially in the production of lateral curvature. Children should never stand for longer than a few minutes at a time; and girls should not stand in class to say lessons, because the dorsal muscles soon become fatigued, and if the upright position is enforced, the attempt to maintain it and relieve the fatigue, whether by standing upon one leg or not, causes the spine to be placed in a curved position. The position usually assumed for writing, drawing, and for other occupations at low tables also conduces to curvature of the spine; therefore the height of the table or desk or the height of the chairs should be so regulated that each individual pupil can work without having to bend the spine laterally. Weak boys and girls should not sit up at a table for long periods, but should work in the position indicated in fig. 90.

CHAPTER XI.

CARIES OF THE SPINE.

Synonyms—*Pott's disease*, Angular curvature; *Kyphosis* (to bend forwards); French, *Cyphose*; German, *Cyphosis*; Italian, *Cifosi*.

CARIES of the spine is a process of ulceration affecting the vertebræ or the intervertebral substances. It usually com-

FIG. 95.

Section of Spine affected by Caries. For description see fig. 103.

FIG. 96.

Caries in the last Dorsal and probably in the adjoining Vertebræ.

mences at the anterior parts, and extends backwards, but seldom attacks the arches of the vertebræ. The result of the loss of substance from the ulceration is generally the production of a somewhat wedge-shaped excavation, the base of which presents anteriorly and the apex posteriorly. This excavation does not usually exist as a space, because the bones above and

FIG. 97.

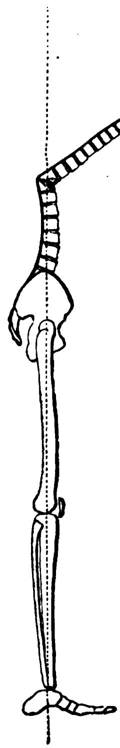
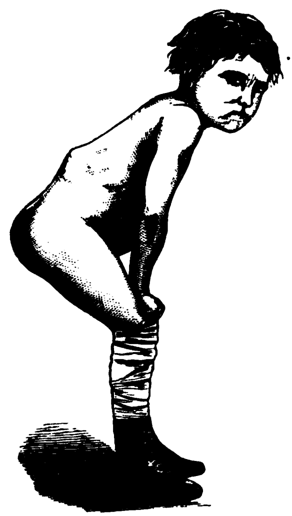


FIG. 98.



(After Sayre.)

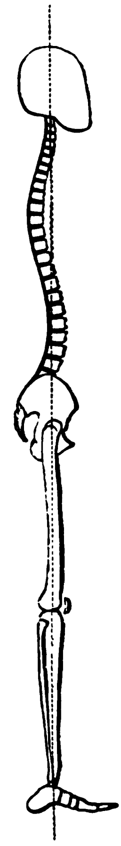
below the seat of disease come together as the caries progresses. Thus there is a falling forwards of the part of the spine above, and an incurvation of the part below the seat of disease, and a projection of the spinous processes in the back. Occasionally, but rarely, the disease attacks the same structures laterally, or at the posterior part of the bodies of the vertebræ (see fig. 105); but it is not until the disease has involved the front part of the vertebræ that an angle in the back is produced.

As the upper portion of the body falls forwards, to allow of the continued conjunction of the bones, the equilibrium is upset, as may be seen by fig. 97. This position is not maintained by the patient, partly because of the disturbed equilibrium, and partly because the position of the head with the face looking more or less downwards is not agreeable to him. Consequently, he raises the upper part of the body, and draws it backwards. Occasionally he will relieve his position by bending forwards and supporting the superincumbent weight by making his arms serve as props upon his thighs, as in fig. 98.

The vertebræ that are involved (and when the disease is severe there are several) are fixed to one another by inflammatory adhesions; but yet, during the period of active disease, the carious surfaces can move to a certain limited extent upon one another, and from and to one another. But the degree to which separation of the diseased surfaces can occur is very slight; so that, when a patient raises, or rather draws backwards, the upper part of his body for the purpose of looking forwards and of equalising his equilibrium, the vertebræ below the seat of disease are allowed to accommodate themselves to the alteration of form, and an appearance of incurvation occurs. We say 'appearance,' because the curve is formed chiefly by an arching back of the vertebræ from the perpendicular line of the body, and not by an arching of the lower vertebræ forwards. In some severe cases, however, there may be a true incurvation as well as an arching back, and the curves may be shown as in fig. 101. There is also an incurvation of the upper part, especially in the neck, in order to allow the face to look forwards; but the bending is chiefly below the seat of disease. The practical bearing of these facts will be dealt with when we consider the subject of treatment.

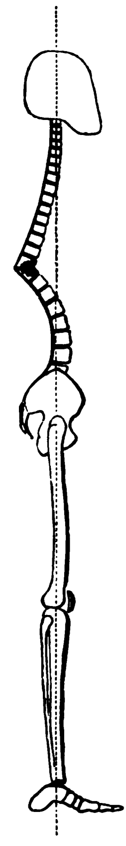
Pathology and Etiology.—Opportunities for making pathological investigations into the morbid anatomy of caries of the spine so rarely occur, that, in order to form an opinion upon the nature of this disease, we are compelled to extend our

Fig. 99.



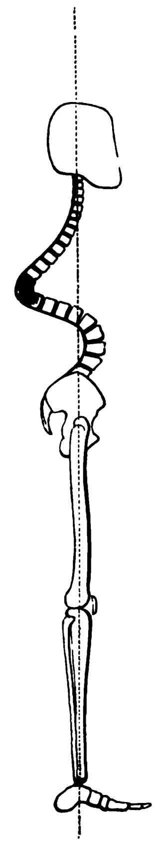
Showing the Natural Curves of the Spine.

Fig. 100.



Showing the Curves formed when Caries exists.

Fig. 101.



Showing the Curves formed in a more severe case than in fig. 100.

enquiries to the consideration of cases of caries of those bones which are more accessible to observation.

We meet with (1) *chronic ostitis, commencing in the periphery of the bone,* usually following or accompanying periostitis; and (2) *ostitis commencing in the centre of the bone,* and independent of periostitis. With regard to the former, its progress is slow and insidious. The periosteum becomes thickened and less firmly attached to the bone, and beneath this membrane particles of new osseous deposit often occur. This form of chronic inflammation is common in syphilis. A further grade is that of suppurative *periostitis,* generally accompanied by superficial suppurative *ostitis* (caries superficialis). The salts of lime gradually disappear, and the organic framework is absorbed by the vessels, the product of the inflammation.

Billroth, whose teaching is here chiefly followed, emphatically urges that if caries arises from an injury, there must yet exist a chief element, either in the injured part or in the whole organism, for otherwise the process of inflammation from the injury 'would run its usual course, as in all traumatic inflammations, and soon come to a termination.'

Syphilis and scrofula, as elements in the whole organism, will predispose to superficial caries. So also, as elements in the injured part, will those circumstances which interfere with the natural process of resolution in a simple and non-specific periostitis. *Thus local disturbance of the inflamed part may cause a lingering chronic process of inflammation (caries).*

In the form of caries which commences in the centre of spongy bones (caries centralis), the salts of lime become soluble and are absorbed, the surrounding tissue becomes more vascular, and the medulla, infiltrated with migratory cells, takes the place of 'the gradually but constantly decreasing bony tissue.' The bones become light and their cortical substance attenuated.

Ostitis may occur in the spongy bones, and therefore in the vertebræ, in consequence of which the bones are penetrated by a mass of interstitial granulations, completely breaking up their tissue without any suppuration. Sir Benjamin Brodie described caries of the spine as sometimes occurring without suppuration, and he considered the origin of such cases to be rheumatism.

Shaffer, of New York, considers these cases of *caries sicca* to be non-scrofulous; and Billroth says that this form is just as variable as regards its vitality as chronic periostitis; that we can here also distinguish some cases which have a distinctly atonic, others a fungous character, while a series of cases lie between these extremes.

Billroth has studied this *caries sicca*, especially in resected joints, and he states that it is seldom or never seen after death, as the granulations would break down into pus during the depression of the vital powers preceding dissolution.

Shaffer considers that in suppurative caries the disease is limited to a few vertebræ and the deformity therefore angular; but that in *caries sicca* many vertebræ are attacked, and the deformity partakes more the nature of a curve; but in the worst cases of suppurative caries that the author has seen, the deformity has been a curve, whereas in an insidious case of caries which was probably without suppuration the deformity was angular.

Ostitis with caseous degeneration is another form occasionally met with, and may be seen as a sequela of typhoid fever, scarlet fever, small-pox, &c.

'Strumous caries, or ulceration,' writes Mr. Holmes,[1] 'appears to me to be identical in essence with all other forms, only that the accompanying softening is more marked in this than in other kinds of ostitis;' and he further states[2] that simple caries commences superficially, the bone not being apparently much altered, except in the immediate vicinity of the ulceration; while in scrofulous caries, the whole, or nearly the whole, bone is softened and infiltrated with oily matter.

Billroth's opinion upon the etiology of chronic ostitis, under which term he includes caries, is, that primary chronic ostitis from a traumatic injury in subjects otherwise healthy happens

[1] *The Surgical Treatment of Children's Diseases.* London, 1869.

[2] *The System of Surgery.*

but rarely. It may happen, however, from violent concussion and compression. He considers that scrofulosis and syphilis are the most frequent causes; that in syphilis the local disease is seldom set up by external agents, while in scrofulosis such may fairly be regarded as the rule.

Percival Pott, who published his work upon the spine in 1779, considered this disease to be a result of a constitutional weakness, and especially of a scrofulous condition of the body. He strongly denounced the theory that an injury could alone cause the disease. The majority of surgical writers since Pott's time have inclined more or less to the doctrine that scrofula is the only cause. Some have recorded cases which have apparently been the result of injury, and in which no ordinary symptoms of scrofula have been present; but, nevertheless, these observers have generally considered that scrofula was necessarily the predisposing cause of the disease.

Another theory of the etiology of this disease is that caries is not essentially a disease of scrofula—that, although scrofulous individuals are more susceptible to the disease than those whose vital powers are greater, yet that the direct cause of the caries is an injury. This view was ably supported by the late Mr. Hilton; and Mr. Holmes and others are also opposed to the opinion that caries is always a scrofulous affection. In America, moreover, much has been written in support of this opinion.

Others state that caries of the spine occurring in children is due to scrofula, and occurring in adults is generally, or often, independent of scrofula, but usually associated with rheumatism. Brodie advocated such a view, and he stated that scrofulous ulceration of the spine begins in the bones, and non-scrofulous in the intervertebral cartilages.

Pirrie[1] considers that the excessive use of mercury will also give rise to ulceration of bone, and that the worst forms of caries occur in scrofulous persons affected with syphilis who have taken a great deal of mercury.

[1] *Principles and Practice of Surgery.* By William Pirrie, F.R.S.E., Professor of Surgery in the University of Aberdeen, &c. 2nd edition.

Scurvy, gout, and rheumatism may also be the predisposing causes of caries, because they depress the vital powers.

The exciting causes are injuries, such as blows; bruises from concussions or sprains; and suppuration or ulceration of the soft parts in the neighbourhood.

From clinical observation, and as being in accordance with the pathology of caries in other bones (as described above), the author has formed the following conclusions :—

1. Caries of the vertebræ very often occurs in patients who present the symptoms which are supposed to indicate scrofula, whatever the true nature of that disease may be.

2. It often occurs in patients who, although delicate, and in a condition which has been called pretubercular, have no decided symptoms of constitutional disease, and who have no family history of disease of any kind.

3. It occurs in patients who have been debilitated by fever, or some other disease calculated to impair nutrition.

4. It sometimes occurs in patients who present no apparent signs of other illness of any kind except the pain following an injury.

When the disease occurs after an injury in apparently robust individuals, it may perhaps arise in the manner now to be described :—

Fractures of the vertebræ *almost always* present the same kind of displacement of the fragments of bone. In consequence of a violent bending forwards of part of the spinal column, the anterior portion of a vertebra is crushed or broken off by the vertebra above it, and the posterior portions of the bodies of the vertebræ are not injured. This common result will probably be recognised in the accompanying illustration (fig. 102.) The crushing of the anterior upper edge of a vertebra seems to be the general tendency of the majority of accidents which injure the bones of the spinal column; and in spinal caries the disease nearly always begins in the same situation. It therefore seems probable that an injury, especially to the bones of a young child, may, although insufficient to cause absolute fracture, be sufficient to injure the anterior part of a vertebra to such an extent that inflammation is set up. Such inflammation would speedily get well, were not the parts subjected every day to an almost constant movement. Now, it is quite in accordance with the pathology of the disease to suspect such frequent irritation capable of ultimately giving rise to caries of the

Fig. 102.

Fracture.

Fig. 103.

Caries.

(From specimens in St. Mary's Hospital Museum.)

injured vertebræ. If it is possible for caries to be set up thus in a healthy child, much more readily will it occur in one whose powers of repair are weak, either in consequence of constitutional delicacy, or as the result of some fever or other disease.

It is very probable that local injury is the exciting cause in the majority of, or in all, the cases; that a slight local injury may cause caries in an unhealthy subject; and that a less slight injury, repair being interfered with as above described, may produce caries in an otherwise healthy subject.

The disease generally occurs during childhood up to the time of puberty, after which period it becomes more rare.

In some cases the ulceration commences in the anterior common ligament; in others it begins in the fibrocartilages; but it is said generally to begin in the bodies of the vertebræ themselves, or in the junction between a vertebra and the cartilage;[1] and the anterior part of the column, as before stated, is *usually* first attacked.

The disease spreads upwards and downwards as well as backwards, and it eventually attacks, in extremely severe

FIG. 104.

Extreme Angular Curvature from extensive Caries of the Lower Dorsal and the Lumbar Vertebræ. The ribs are not shown in the drawing, but the articulations of the lower seven are involved in the disease. (From a preparation in St. Mary's Hospital Museum.)

cases, the articulations both of the ribs and of the articular processes.

Caries sometimes commences in other parts of the bodies of the vertebræ, and is then probably generally associated with scrofula. Under such circumstances the symptoms may be insidious and the progress of the disease slow. Fig. 105 represents such a case. It is described in the Museum Catalogue (A. 6,142) as caries of dorsal vertebræ in a male, aged 21.

[1] See Hilton, *Lectures on Rest and Pain*, 3rd edition. Edited by Jacobson, 1880.

He had been ill only one month before admission for *pleurisy*. No symptoms of the caries were complained of, and the diseased state of the bones was only discovered at the *post-mortem* examination. He died from 'croupous pneumonia.' The 6th, 7th, 8th, 9th, and 10th dorsal vertebræ were involved. There was an abscess, which had reached the *dura mater*, but the spinal cord and its membranes were not affected. It is obvious that, in such cases, the diseased parts are not subject to so much compression or disturbance from the movements of the body as in the commoner forms of the disease, and therefore the symptoms are more obscure.

FIG. 105.

(From a preparation in St. Mary's Hospital Museum.)

The condition of the spinal cord when examined after death varies considerably. Generally, although the deformity may have been very marked, the cord has no appearance of abnormality; but, in some cases, the membranes alone, or with the cord, present various symptoms of congestion and inflammation, or of the results of those processes, such as thickening, suppuration of the membranes, or softening of the cord. The cord is not often pressed upon by the deformity, and if such pressure does occur, the projecting bone, it is said, becomes in time (Stafford) absorbed and rounded off. The angle that is formed in the cord, to correspond with the altered shape of the spinal column, does not alone affect its functions, as the slow progress of the bending allows the medulla to accommodate itself to its new position.

In paraplegia, the powers of motion only are generally lost, and this fact is in accordance with what one might suppose, as the disease in progressing backwards from the bodies of the vertebræ would necessarily first encounter the anterior columns of the cord. (See A. Shaw, Mr. Holmes's 'System of Surgery,' p. 132, vol. iv.)

Disease of the Upper Two Cervical Vertebræ

Is more dangerous than disease of other parts of the spinal column, because

(1) The diseased structures are in closer proximity to the spinal canal; and

(2) The *medulla oblongata* is situated in this portion of the canal.

The articulation between the axis and atlas is that at which the chief rotatory movements of the head take place, and it is, therefore, very subject to injury by shocks and sprains.

Disease of this articulation is usually chronic in its nature. The synovial membranes and ligaments, which connect the two vertebræ, become inflamed and softened, and ultimately ulcerated. The disease extends thence to the bones. The ligaments being weakened, the weight of the head, carrying with it the atlas, causes the latter bone to glide forwards and downwards upon the axis. Consequently the odontoid process, stretching the transverse ligament, presses upon the cord, and if the ligament gives way sudden death is the usual result. But a great deal of stretching and displacement may exist without injury to the cord, and if the cases are carefully treated, they may recover, either perfectly or with some slight amount of deformity.

Even when paraplegia occurs from pressure upon the cord, the patient may recover from the severer symptoms.

Symptoms of Caries of the Spine.—The first symptoms are languor, listlessness, unwillingness to move much, or at all briskly, and there is often dull heavy pain in the back. If pain is the first symptom, it may date from the time of a fall, or other traumatic injury. After a time the child begins to stumble in walking, and upon attempting to move quickly his legs involuntarily cross each other; upon attempting to stand erect his knees often 'give way,' and he is soon unable to stand without support.

Projection of the spinous processes of the affected vertebræ will probably have occurred before this period, and the projection is very often the first symptom noticed. Pain is often referred to the hip, knee, and ankle, and the affection has been mistaken for disease of one or other of these joints.

The supine horizontal posture usually affords some relief to the patient, but the prone position is usually much more effective in relieving pain.

As the disease progresses, cramps and convulsive movements occur in the legs. A chilly feeling is complained of; the appetite fails; the pulse becomes rapid and feeble, and sometimes irregular, until the whole health breaks down. The patient becomes unable to direct either of his feet precisely to an exact point; and very soon after this both thighs and legs loose a good deal of their natural sensibility, and become perfectly useless for purposes of locomotion.

Complete paralysis may eventually take place below the diseased vertebræ, involving the rectum and bladder, and causing atrophy of the muscles of both legs.

When paralysis exists, bed sores readily form. But disease may be very extensive in any region without causing paralysis.

The symptoms naturally vary in accordance with the seat of the disease.

If the disease be in the cervical vertebræ, difficulty of respiration may be present; if in the dorsal, indigestion, pain and 'tightness at the stomach' may be felt; if in the lumbar region, the pelvic viscera may show symptoms of nerve irritation.

The discomfort at the epigastrium is sometimes, though not very often, described by the patient as resembling the sensation of a cord tied tightly round the body, but in very young children the symptoms of pain are less definite. Pain, situated in the parieties, is usually symmetrical, but when the disease is situated between the occiput and the atlas, it may be on one side only.[1]

Pain is the result of irritation of the nerves which supply the bones in the neighbourhood of the caries.[2] It is a very uncertain symptom, for it may vary much in degree. Exacer-

[1] See Hilton, *op. cit.* p. 86.

[2] See Shaffer, *Pott's Disease*, New York, 1879.

bation of pain commonly occurs suddenly in the night, and this causes the child to utter a very characteristic piercing cry.

Local Heat and Swelling are often present, more or less, as long as the disease is actively progressing.

Cases sometimes occur in which the progress of the disease is so insidious that an angle is formed, and ankylosis takes place without any symptoms of ill-health or pain having been noticed, the child having played about as usual during the whole time.

Effect of the Disease upon the Form of the Body.—The deformity of the back, which increases as the disease advances, becomes a very important symptom.

Its form is sometimes a curve, several vertebræ taking a share in the prominence, but more often the projection is perfectly angular, the spinous process of one vertebra being more prominent than the rest.

In the course of time the muscles upon each side of the spinous processes atrophy, and so cause the *angle* to become more pronounced.

The projection appears sooner, and increases most rapidly when the disease is situated in the dorsal region. This result is the consequence of the natural curve of the dorsal region being backwards, and so not only does the disease increase more rapidly here, but the spinous processes project more than they do when the disease is situated in the other regions of the spine. In the lumbar region the natural forward curve has to be obliterated before a posterior projection is formed. Therefore the amount of projection is not a sure indication of the extent of the disease, unless its situation be taken into account.

These remarks apply more to cases in which the deformity is a curve than to those in which it is an angle.

If the disease be situated in the lower lumbar or upper sacral region, *incurvation* of the vertebræ above the disease may be the most marked abnormal appearance.

When the disease is situated in the cervical region, 'the head subsides vertically, so as to approximate to the upper part of the chest, and obliterate the appearance of the neck.

Accordingly, the occiput comes in the way of an examination, preventing the tips of the spinous processes from being felt by the fingers.'[1]

In these cases the head may assume various positions.

Diagnosis.—Up to the age of puberty, and in girls a few years after this period, the curves natural to the adult spine are not entirely formed. This condition, in conjunction with the great flexibility of the column in early life, gives rise to appearances which are often deceptive. Projections appear at various parts, and especially in the lumbar region, which may be mistaken for a symptom of commencing caries.

If the surgeon cannot satisfy himself as to the diagnosis by careful manipulation, he may do so by placing the child in the prone position, and raising the hips above the level of the spine. If there is no disease the angle will disappear.

When there is difficulty in forming a diagnosis, pain not being present during ordinary movements, it has been advised to give a shock to the spine, by causing a sudden pressure upon the shoulders when the patient is standing. which will generally cause some pain if disease be present; or, that the patient should be caused to jump off a stool or chair; or, that the spine should be percussed. But these violent measures are unnecessary, and might be productive of much harm; besides, they are uncertain tests.

Percussion, pressure, or the application of heat, in the supposed region of disease, are all uncertain modes of diagnosis, as disease may be present without such means eliciting any pain, and pain may be thus caused although no caries or other serious disease be present.

In distinguishing abdominal and thoracic pain, the result of caries of the vertebræ from that of affections of the viscera, we find that recumbency generally more quickly relieves the former than the latter.

All jarring and jolting movements, especially when the

[1] A. Shaw, in Holmes's *System of Surgery*, 2nd edition.

muscles are relaxed, increase the pain in caries, and a false step is very distressing to the patient.[1]

This pain in the parietes of the thorax or abdomen, when it exists (and it is often the earliest symptom), is usually, as already stated, symmetrical upon the two sides of the body. Mr. Hilton[2] has well described the practical bearing of this fact, stating that by tracing 'the nerves producing these surface pains backwards to the posterior median line, and noting accurately the healthy or unhealthy condition of the various structures near which those intercostal nerves would pass—such as the ribs, pleuræ, aorta, œsophagus, and other structures in the posterior mediastinum—we arrive at the vertebræ and spinal marrow, and in that way, proceeding by the law of exclusion, we arrive at the diseased spine as the real cause of the pains experienced at the pit of the stomach.' Mr. Hilton afterwards refers to a case in which disease of the spine was supposed to be present. Pain was felt upon the surface of the side of the thorax, but was on one side only. 'Upon tracing the posterior course of the fourth dorsal nerve towards the spine' an aneurism was detected, the spine being free from disease. It may here be remarked that aneurism may cause, by pressure, absorption of the bodies of the vertebræ which might cause a projection in the back. In examining the spine, various movements, carefully performed by the patient, will show the surgeon whether the column is entirely flexible, or is rigid in any part—stooping, for instance, to pick up some small object from the floor, or turning sideways while recumbent.

The manner in which a child affected with diseased vertebræ will steady his spine, and keep it rigid while picking up a small object from the floor, is very characteristic. He will bend his knees, but not his back, and will support himself by placing one hand upon his thigh, while he bends his body sideways towards the floor.

[1] See a paper by Howard Marsh, in the *British Medical Journal*, June 11, 1881.

[2] *Op. cit.* chap. iv.

The patient with caries will relieve the superincumbent weight in many ways. For instance, if the disease is in the cervical region, he will sit with his elbows upon the table, or other convenient support, and rest his chin upon his hands.

When the disease is situated in the two upper cervical vertebræ the protrusion of the spinous process of the axis, which cannot in the normal condition be felt, will help to indicate the nature of the case.

If the disease of the vertebræ is malignant or syphilitic the symptoms will probably be modified by characteristic complications.

In adults the *vertebra prominens* may project so much as to give the appearance of angular curvature, and in some instances a neuralgic pain occurs in this portion of the spine of a very severe character.

This affection is occasionally associated with hysteria, and the neuralgic pain may occur in other parts of the spine. These cases often present many difficulties in diagnosis, but may generally be detected by observing that there is no rigidity of the spine, that the patient evinces extreme sensitiveness to the slightest touch, and that the history of the case is not in accordance with that of caries. If the pain has been present for several months, and there is no deformity, it is probable, but not absolutely certain, that caries of the spine does not exist.

Hysterical Paraplegia has sometimes been mistaken for the result of caries of the spine, and considerable difficulty may arise in forming a correct diagnosis.

In considering these cases, the fact that so-called hysterical symptoms frequently *accompany* caries of the vertebræ, must not be forgotten; and Stafford's supposition that the fluctuating pains experienced by these patients are brought about by some implication or irritation of the sympathetic ganglia, has probably much truth in it.

Abscess.—Partly from the irritation caused by the disease to the neighbouring parts, and partly from the burrowing of the pus discharged by the ulcerating vertebræ themselves, large abscesses are sometimes formed.

Abscess is a very serious symptom. It plays an important part among the causes of death in most of the fatal cases. A collection of pus having once commenced, is soon increased by (1) the frequent movements of the parts, and (2) by the lax condition of the tissues in front of the spine caused by the deformity.

Symptoms of Abscess.—The formation of an abscess is generally accompanied by derangement of the general health; slight pyrexial symptoms in the evening; occasionally perspirations at night; but rarely rigors.[1] The early symptoms may, however, be obscure. Pain may be absent or very severe.

In advanced stages there will be painful spasmodic muscular 'twitchings' and neuralgic pains in the groin and thigh, stiffness and pain in the spine, increased by extension of the thigh. The patient experiences a difficulty in standing; he stoops, and cannot assume a perfectly upright position, because of pain in his groins and loins; he can ascend better than he can descend stairs.

Abscess has been mistaken for rheumatism, affections of the kidneys, coxalgia, hæmorrhoidal pains, glandular swellings and hernia, cæcal abscess, cancer, and other affections.

Spinal abscesses may acquire great dimensions, and are then very dangerous in their consequences.[2] Like all abscesses, they take the course of least resistance; and this is down the sides of the bodies of the vertebræ. Occasionally, but not usually, the abscess passes down both sides.[3] If the disease is in the dorsal vertebræ the abscess encounters the diaphragm in

[1] Temperature often reaches 102° and 103° F. Schaffer has seen it 105°.

[2] See the article by Mr. Alexander Shaw, in Mr. Holmes's *System of Surgery*, to which the author is indebted for many of his remarks upon abscesses.

[3] In these 'bifurcated' abscesses one only may be present in the groin, the other being in a less advanced stage.

its downward course, and penetrates the substance of the psoas muscle, being hindered from keeping to the surface by the *ligamentum arcuatum internum.*

More or less of the substance of the psoas becomes enclosed in the abscess. The abscess is hindered from extending inwardly by the fascia iliaca, but is less restrained outwardly. It occupies the hollow between the iliacus and psoas muscles on the inside, and the ilium on the outside. It usually projects below Poupart's ligament, between the tendon of iliacus and psoas, and the anterior inferior spinous process of the ilium—that is, between the outer and middle thirds of poupart's ligament. The abscess may open in the groin, but it more commonly descends further down the thigh, inwards and forwards, being limited externally by the sartorius muscle; or it may turn inwards over the adductor longus; but the direction and position of opening will vary in different cases; the abscess may ascend on the abdominal muscles.

The 'neck' of the abscess, when it passes from the abdominal cavity into the thigh, may be more or less contracted, and so retard the flow of pus, or even make it difficult to determine whether there is any communication between the abscess in the groin and the abdominal cavity.

Psoas abscess has been known to make its way into the spermatic canal, and appear at the external abdominal ring, like an inguinal hernia.

Instead of pursuing its course down the psoas muscle an abscess may make its way posteriorly below the last rib, through the quadratus lumborum and to the outside of the sacro-lumbalis muscle. It is then called a lumbar abscess.

Psoas and lumbar abscesses have passed over the crest of the ilium, and opened over the glutal muscles.

A spinal abscess may also penetrate the lung. A. J. Shaw mentions a case in which the patient coughed up several pieces of bone.

The pus has also been known to enter the urinary bladder, or to proceed through the sacro-sciatic foramen, and present at the nates; and Stafford records a case in which exit took place between the eighth and ninth ribs.

Abscess in connection with diseased cervical vertebræ usually pursues a lateral course, and reaches the surface upon one or other side or both sides of the neck.

Treatment.

Before the time of Percival Pott (who wrote in 1779), the nature of this disease was little understood, and the treatment was consequently very unscientific and inefficient.

Pott appears to have been a very careful observer, as evinced by his description of the progress of the disease from its commencement to its termination in paralysis, abscesses, and death—results which at his time were extremely frequent. Violent attempts to straighten out the spine used to be made in those days, and Pott recognised the evil of such treatment. He pointed out that to draw the carious bones asunder could not be beneficial, as it would interfere with the natural mode of cure by juncture and coalescence of the diseased bones. This opinion was founded upon sound surgical principles, and holds good to the present day.[1]

Notwithstanding Pott's belief in the constitutional nature of the disease, the treatment which he advocated was entirely local in its nature. 'If the cure,' he writes, 'had depended upon an application to the constitution in general, it might have required a variety of medicines, the administration of which must have demanded judgment in adapting them to particular persons and constitutions. But, fortunately, the means of relief are simple, uniform, and safely applicable to every individual. . . . It consists merely in producing a large discharge of matter from underneath the membrana adiposa on

[1] Stafford, subsequently, not only deprecated attempts at separation of the diseased bones, but went to the other extreme, and advised that means should be taken to press them together.

each side of the distempered bones forming the curvature, and in maintaining such discharge until the patient shall have recovered his health and limbs. . . .'

Pott stated that in the three years during which he had been treating cases by this means he met with but one instance in which it failed when there was '*any reasonable foundation for hope*.' But he neither states how many he cured nor what kind of cases these hopeless ones were.

For many years after Pott's publication, surgeons employed counter-irritation, such as issues, setons, moxas, perpetual blisters, and the actual cautery; they insisted also upon the desirability of recumbency, which, in fact, was necessitated by the wounds that were produced. But counter-irritation gradually fell into disuse; for it was found, that if the diseased parts were kept at rest, the patient progressed quite as well without as with the employment of such severe remedies.

Sir B. Brodie stated that his experience proved to him that issues and setons, and the like, were useless and even injurious, except in some adult cases.

Bampfield, in 1824, insisted upon the horizontal position being maintained for many months, the supine position being sometimes relieved by the prone for two or three months, or longer. To maintain the spine in a quiescent state he employed bandages round the thorax, with a shield over the projection; and when he considered that inflammatory action and efforts of repair had ceased, he used pressure over the projection and extension of the spine.

Beale, in 1830, recommended chiefly constitutional remedies, tonics, absolute horizontal rest, blisters, setons, or moxas.

Tuson, in 1841, drew a wide distinction between scrofulous and other cases. In the former he deprecated the use of counter-irritants, but advocated them in the latter. In all cases he employed gentle extension.

M. Pravez, of Lyons,[1] treated his cases by baths of compressed air.

M. Bonnet, of Lyons, advocated cod-liver oil, sea baths, and terebinthinate baths, and he objected to violent extension, for fear of producing a space between the bodies of the vertebræ, which would prevent all firmness at the point of disease. 'At the same time,' he writes, 'if we must not extend (*redresser*) the parts, is it not desirable to diminish the pressure of the upper parts of the body, and to immobilise as much as possible the parts which have been separated by the caries?'

We cannot doubt but that Bonnet's question should be answered in the affirmative; but the subject that we have to consider is, *What are the best means* for obtaining relief from the pressure, and for fixing the spine?

The objects we should have in view are—

1. To rest the diseased parts.
2. To support the superincumbent weight.
3. To improve the general health.

The first and second must generally be thoroughly carried out before the third can be effected.

From the time of Pott until recently the majority of surgeons have agreed upon the importance of rest to the diseased structures; but their opinions have differed considerably with regard to the manner in which such rest should be afforded. The following plans have been employed :—

Recumbency—

a. Supine position.
b. Prone position.

'Spinal supports'—

Back splints in conjunction with recumbency.

Plaster of Paris, felt, and other jackets } without recumbency.

It has been asserted that, by confining the patient to the recumbent posture, especially in scrofulous cases, the general health will suffer; but experience proves otherwise. Recum-

[1] *Essai médical sur l'Emploi de l'Air comprimé*, Lyons, 1850.

oency, when so employed that it affords complete rest to the spine, relieves the patient from pain and irritation. The lost appetite returns; sleep, hitherto disturbed, becomes natural and refreshing, and the health rapidly improves.

That the patient should be able to take exercise in the open air, and that most of the inconveniences, troubles, and expenses of the sick room should be done away with, are the points urged in favour of treatment without recumbency. But, if to gain these advantages we run the risk of interfering with the progress of the disease towards recovery, we ought certainly to hesitate before adopting such a mode of treatment.

Fresh air and exercise are very valuable adjuncts to the treatment of delicate subjects. Fresh air can, and should, be afforded to the patient under any mode of treatment, but exercise, if it moves the diseased structures, is as contra-indicated in caries of the vertebræ as it is in the early treatment of a fractured leg.

Recumbency.

Recumbency may be either in the supine or in the prone position. The former is that usually adopted, and may be carried out as follows :—

Recumbency in the Supine Position.

The Bed or Couch.—If the deformity is very slight, the patient may lie upon a hair mattress. The surface of the mattress may be hollowed out to receive the projection of the spine, if necessary.

If the case is severe, a water bed should be provided, and it may be necessary to have side supports to prevent the bed from rolling off the couch. The water bed should be filled only sufficiently to prevent the upper and under surfaces touching when the patient is placed upon it. This result is obtained when about three-fifths of the bed's capacity is filled. A firm mattress should be placed beneath the water bed, and blankets upon the top. If the patient cannot be otherwise kept quiet, wide webbing straps are to be placed diagonally across his shoulders, pelvis, and legs. It will be an advantage if the couch is provided with good wheels, so that the patient can be taken from one room to another without being jolted. The surface of the couch should consist of a removable tray, so that the patient (with his mattress and water bed) can be lifted into a perambulator or carriage with as little disturbance as possible.

Some surgeons employ a double-inclined plane couch, so that the shoulders and knees of the patient can be raised or lowered at pleasure; but such movements are easily abused, and the strictly recumbent position is safer. In fact, the patient should not be allowed to move his back more than can possibly be helped. He should be fed in the recumbent position, and the bed pan should always be used. If the water bed is only partially filled, as above directed, the pan can be easily pushed beneath the patient.

Recumbency in the Prone Position.

The prone position offers many advantages over the supine as a means of resting the diseased structure. These advantages may be tabulated as follows :—

1. It removes the weight of the body from resting upon the spine.

2. It restrains the action of the abdominal and other muscles in front of the spine, so that the part of the body above the deformity is not bent forwards.

3. It allows use of the arms for feeding, play, &c., without causing the body to bend forward and press the diseased bones together. When the metal splint, to be presently described, is adapted, such movement of the spine does not take place, but even then the prone position is usually much more comfortable to the patient than the supine.[1]

[1] The good effects of the prone position are well shown by the comfort which the patients experience when removed to a prone couch from an ordinary bed. This treatment is thoroughly carried out in the City Orthopædic Hospital.

An objection has been raised to the prone position, that it might allow the gravitation of abscesses forwards; but no such result has been known to occur.

It was originally employed very extensively by Verrall, who founded the Society for Diseases of the Spine and Hip, since become the National Orthopædic Hospital.

Recumbency is necessary as long as the disease is in an active condition; but when this is passed, the patient may be allowed to walk about, if the spine is properly supported by an efficient apparatus.

Mechanical Support.—For the same reasons that we apply splints to a broken leg or a diseased joint, so we should apply some local support to the diseased spine. A well-adapted apparatus to support the back is even a more important element in the treatment than the recumbency; and slight cases will sometimes get well by means of the splint alone.

Spinal Supports.—The chief objects to be effected by spinal supports are—

1. To relieve the diseased portion of the column from the weight of the superincumbent parts of the body.

2. To fix the spine so that the diseased vertebræ may not move upon one another.

3. To relieve pain and to counteract increase of deformity.

The best apparatus will be that which can accomplish these objects without being irksome to the patient, and without being injurious to his general health.

Apparatus for Spinal Support.

Jackets—
- Plaster of Paris.
- Stiffened felt.
- Paraffin.

Back splints—
- Moulded leather.
- " guttapercha.
- " felt and similar substances.

Framework supports, with crutches.

Adaptable metal splints.

Dr. Sayre, of New York, introduced into this country, a few years ago, the practice of suspending the patient by the head and arms, encasing him in a plaster of Paris jacket, and allowing him free locomotion in the place of recumbency.[1]

This mode of treatment[2] has been very extensively employed in England, with the following results:—

That, when compared with no treatment at all, or when compared with that very inefficient mode of treatment, supine recumbency in bed, without any special means for fixation of the spine, the results of the plaster of Paris jacket treatment appear at first remarkably satisfactory. When, however, we take all the facts connected with the subject into consideration, it becomes evident that the plaster of Paris jacket is not the best spinal support which we have at our disposal.

The Disadvantages of the Plaster of Paris Jacket.

1. The surgeon is unable to watch the progress of the disease, so that the angle may increase (from extension of the caries), abscesses may form, and ulcerations occur without his or the patient's knowledge;[3] moreover, as the progress of the disease cannot be watched, the surgeon has no indication for the readjustment of the bandages.

2. Perspiration is checked; and, among the poor, vermin are likely to congregate beneath the casing.

3. It interferes with or prevents thoracic respiration, and so favours collapse of the thoracic walls.

4. It retards the growth of the whole trunk, and especially of the thorax, and may thus cause considerable mischief when worn for three, six, or even sixteen to twenty months without removal.[4]

[1] *Spinal Disease and Curvature.* By Louis A. Sayre. London, 1877.

[2] See Glisson's system, *B. Med. and Chir. Rev.*, October 1861.

[3] Many instances of each of these occurrences have been seen by the author.

[4] Even if the jacket be removed and reapplied frequently, still

Suspension, by Sayre's hanging apparatus, by which the patient is raised by the head and shoulders until nearly the whole weight of the body is removed from the ground, increases the height of the patient by straightening the natural curves and stretching out the intervertebral substances above and below the area of disease. If the diseased bones themselves were separated to any great extent from one another, the results would be very harmful and probably fatal. Such unfortunate results have been recorded; and extension of the spine in this rough and unscientific manner must always be attended with a considerable degree of risk.

During suspension the plaster of Paris bandages are applied, and the patient is then removed to a recumbent position, in which he remains until the plaster has 'set.'

The chief object of applying the plaster of Paris jacket to the patient in the extended position is to remove the superincumbent weight from the disease; but, soon after its application, the thorax subsides within the jacket, and the pressure upon the diseased bones may become nearly as much as it was before.

Although the support afforded by the jacket may be sufficient to relieve the patient from much pain, and to allow him to run about, it is not sufficient to prevent enough movement of the spine to cause irritation of the diseased bones.

Dr. Walker, of Peterborough, considering the process of suspension inconvenient and sometimes dangerous, applies the jacket to the patients while they lie recumbent, somewhat in the manner of a many-tailed bandage.

Mr. Davy places his patients in a hammock, and applies the plaster bandage outside.

Mr. E. Owen applies the bandage without the suspension.[1]

growth is not permitted to proceed, because the evil is kept up by the reapplication of the jacket.

[1] Dr. Webb (Australia) employs daily suspension without a bandage.

There have been several other modifications of plaster of Paris bandages for this disease.[1]

Poroplastic felt jackets (which, however, are not porous) have been offered as substitutes for plaster of Paris jackets, over which they have the advantage of being readily removable; but as a means of support they are even less efficacious than the plaster of Paris bandage.

Paraffin has been used in a similar manner to plaster of Paris.

Splints may be made of leather, stiffened felt, and other materials, moulded to the back, and attached to the patient by means of bandages or straps to the pelvis, abdomen, and shoulders.

Good results may be obtained by their use in conjunction with recumbency; but they cannot be very readily or accurately altered in shape to suit the requirements of the case.

Metal supports are generally based upon the principle of propping up the spine by means of crutches from a pelvic belt to the axillæ.

This principle is not a good one, because—

The arms, being very movable upon the thorax in the direction of the crutches, fixation of the spine is not secured. If the shoulders were propped up sufficiently high to effect fixation, the restraint would be unbearable and the axillary nerves and vessels would be seriously influenced by pressure, paralysis of the arms occurring sometimes from this cause. Whereas, if the crutches are only sufficiently high to be quite comfortable to the patient, their use becomes very slight indeed.

As stated above, the raising of the upper part of the body into a more upright position only, does not remove the superincumbent weight from the diseased parts, because the vertebræ below the disease are allowed to curve so as to accommodate themselves to the alteration above. Instruments, with crutches, do not provide means to prevent this incurvation; and when they

[1] T. Wyeth, of New York, *New York Med. Record*, 1879, &c.

are provided with upright stems in the region of the spine, these are made to fit into the lower curve, and little or no control is brought to bear upon the tendency to incurvation.

The requirements of a splint are—

To fix the spine;

To relieve the diseased parts from the pressure of the superincumbent weight;

To relieve pain; and

To counteract further deformity.

These requirements are thoroughly effected by Mr. Chance's adaptable metal splint; and the author is acquainted with no other apparatus (hitherto made generally known) that can act so well. This splint is described below.

Dr. Taylor's antero-posterior support possesses some of the good points of, but is inferior to, that devised by Mr. Chance. It is constructed without crutches.

Mr. Willett[1] recognised some advantage from the use of Dr. Taylor's apparatus, and adopted it with success. He also employed a cheap modification of it for poor people.

Taylor does not profess to fix the spine with his apparatus. He straightens the spine by leverage, and tries to get the superincumbent weight to be supported by the posterior sound parts of the column; but he allows the muscles of the back free play by providing joints in the splint, allowing backward motion. He encourages active movement by the patient, and endeavours to remove the deformity. Moreover, no very effective means seem to be employed to control the lower part of the spine, and the failure of Taylor's instrument in this respect led Mr. Willett to cease using it.

Dr. Shaffer[2] uses an improved form of Dr. Taylor's splint; but it must be difficult to adjust and readjust it. The thoracic belt is objectionable, and the plaster of Paris zone is not placed in a good position—it is too high.

Mr. Chance's Adaptable Metal Splint consists of two light

[1] *St. Bartholomew's Hospital Reports*, 1872.

[2] *Pott's Disease*, New York, 1879.

metal bars passing from a pelvic belt upwards—one upon each side of the spinous processes of the vertebræ. These bars are bent to accord with the angle of deformity, and they reach as high as the level of the shoulders. Fixed to the upper ends of the bars is a pad, to which is attached shoulder straps. At the angle of deformity each bar is separated from the back by a pad. Between the angle and the pelvic belt are attached straps, which extend to an abdominal belt. Between the projecting portion of the spine and the pelvic belt the bars do not fit into the curve of the back, as it is not desirable to perpetuate that curve; but, on the contrary, it is of advantage to control the tendency to curvation, and to allow room for an improvement in position of the vertebræ of this portion of the spine; and the abdominal belt acts in such manner.

FIG. 106.

It has been already stated that caries of the vertebræ commonly commences in the anterior parts of the vertebræ, and extends backwards; the transverse processes and the arches are very rarely involved, not even in so severe a case as that represented in fig. 104.

Therefore the relief of the diseased parts from the superincumbent weight (which has been generally admitted to be a desirable effect of treatment) can be thoroughly effected by drawing the upper part of the spine backwards, if at the same time the lower vertebræ are restrained from bending forwards.

If the body is supported by the pelvis and the thorax in a horizontal prone position, the weight of the body tends to relieve the seat of disease from pressure, and the intervertebral discs above and below the seat of disease will be less compressed anteriorly than posteriorly. This plan relieves the diseased parts much more effectually than does suspension. The two processes should not, perhaps, be compared together, because in suspension nearly the whole weight of the body below the seat of disease is brought to act upon the spine, whereas in the mode of procedure now under consideration no such force is used.

When the spine is in this position (which is usually one of

FIG. 107.

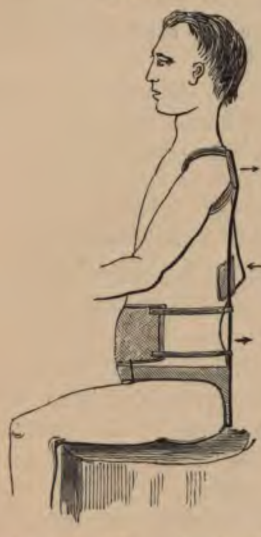
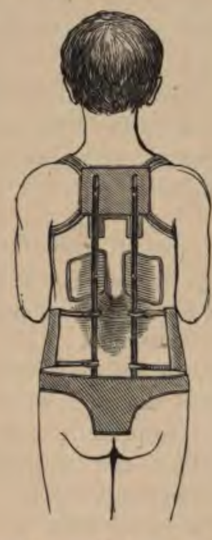


FIG. 108.



comfort to the patient), the apparatus is applied to the deformity—the result being that both the upper and the lower part of the spine are retained in a fixed position, the abdominal belt restraining the curving of those vertebræ which are below the seat of disease. Thus the diseased parts are relieved from pressure by the spine being retained in one position, the apparatus taking its bearing at the three points shown by arrows in fig. 107.

From the above description it must not be inferred that any force is to be used to straighten the spine, but that the spine is simply retained in a position which allows the superincumbent weight to be borne by the posterior sound parts of the vertebræ, while the anterior diseased portion is relieved from pressure. Movement of the upper diseased surface upon the lower is also controlled. An important peculiarity of this instrument is, that it can be adjusted and readjusted by the surgeon himself, and so can be immediately altered whenever necessary during the progress of the case. When the disease is situated in other than the anterior parts of the bodies this apparatus is also valuable because it so thoroughly fixes the spine.

As the disease approaches resolution, changes in position of the structures at the seat of disease naturally occur, and the apparatus must be modified in accordance with these alterations.

Disease of the Lower Lumbar or Sacral Vertebræ.

The instrument just described will be found of less use for these cases than when the disease is situated higher in the vertebral column.

When active disease has ceased, and slight support is required, the splint will be sufficiently serviceable; but, if active disease be present, it may be necessary to fix the pelvis and spine upon one another by continuing the back splint to the thighs, as recommended for hip-joint disease.

The prone couch is a very desirable means of recumbency for these cases.

Disease situated in the two or three Upper Dorsal, or the Lower five Cervical Vertebræ.

In these cases, although we must restrain the movements of all the vertebræ above referred to, yet the movements of the head, which depend upon the two first cervical vertebræ, may be left free.

The apparatus, already described as 'Chance's adaptable metal splint,' is fitted with an upright metal rod, reaching to the back of the head. This is adjustable by means of rack joints; and a band passes round the head, and is attached to a pivot which rotates in the extremity of the upright stem.

Caries of the Upper two Cervical Vertebræ.

Treatment.—The early diagnosis and treatment of caries, when situated in this portion of the spine, is a matter of urgent importance.

The danger which exists of the disease affecting the medulla oblongata, either by an extension of the inflammatory processes to this nervous centre, or from sudden displacement of the bones, is a subject which is discussed in works upon general surgery.

The most important, or perhaps the only necessary, treatment is *rest* to the diseased parts.

It is with regard to the manner in which this rest is to be given that some remarks are deemed necessary.

Recumbency in the supine position, support of the nape of the neck by a pillow, and retention of the head in one position by means of sand-bags placed upon each side of it, is the plan often adopted.

That such a means of treatment, if carefully carried out, may be successful, is proved by the cures that have followed its employment; and the highly interesting cases recorded by Mr. Hilton[1] would alone show how much may be effected in this manner. But even in these cases, if, in addition to the immediate treatment by support with pillows and sand bags, an efficient apparatus had been constructed and carefully adapted, these patients might have been saved much irksomeness and discomfort, and have been enabled to move about at an earlier period; in fact, the whole treatment might have been conducted with much greater safety.

A great variety of instruments have been employed for the

[1] *Op. cit.* chap. v.

purpose of fixing this portion of the spinal column, but the majority of them are unscientific and inefficient.

Steel collars and a variety of 'jury masts' have been used.

The chief fault in these instruments is, that they usually attempt to fix the head by taking a bearing, more or less against the lower jaw. If the lower jaw be fixed, every movement of the mouth, either in talking or mastication, must be made by movement of the cranium, and thus the diseased parts are disturbed. The frame-work upon which these 'jury masts' are raised is also sometimes rather clumsy.

To fix the head upon the spine, and retain the upper cervical vertebræ at rest, an apparatus should be constructed similar to that recommended for caries in the cervical region, but no movement whatever is to be allowed, no pivot action being employed.

The purpose of the rack joints, which are situated near the cranium, and opposite the lower part of the neck, is to allow the head to be adjusted to a position of comfort to the patient.

Treatment of Abscess.—In all cases of caries of the vertebræ abscesses should be watched for, and when found they should be carefully protected from injury. They are generally very slow in their progress, often remain dormant for weeks or months, and occasionally disappear without being treated in any special manner. Gentle pressure has been recommended, as likely to cause absorption of the pus, and Esmarch, of Keil, has employed ice for the same purpose, with apparent good results. However, if the diseased parts are thoroughly rested and the abscess protected from injury, and (if painful) bathed occasionally with hot water, in very many instances the dispersion of the contents of the abscess will take place.

If the abscess threatens to open spontaneously, or if it increases rapidly, its contents should be evacuated. This may be done by making a valvular opening, or by a trocar and canula, or by means of the aspirator. See treatment of abscess in hip-joint disease.

If the opening be closed directly the pus has ceased to flow, and the parts be carefully supported by plaster and bandage, the air will not enter the cavity, and therefore no bad results from the operation will occur; but antiseptic precautions, as recommended by Lister, will increase the safety of the operation.

Another manner of dealing with these chronic abscesses is that which Mr. Callender advocated, namely, the hyperdistension of the cavity (after evacuation of the pus) with a solution of carbolic acid in water (1 part to 40).

Constitutional Treatment.—This must vary in accordance with the nature of the case. In scrofulous cases, iron (the syrupus ferri phosphatis compositus is especially good), cod-liver oil, sarsaparilla, or other tonics, will be useful. The diet must be carefully attended to; good, nutritious, and easily-digested food, and little or no alcoholic drinks, should be given. Small doses of hydrargyrum cum cretâ, or other mercurials, have been highly recommended, and may sometimes be beneficial. All the excretions should receive attention, and be stimulated if necessary.

The patient should breathe as pure an air as possible.

In patients who are not scrofulous, the above-described remedies may be more or less necessary; and the surgeon should carefully watch his case.

Prognosis.—If treatment be commenced before the health has been undermined by the formation of extensive abscesses, or other severe conditions (supposing there is no tuberculosis), a favourable prognosis may usually be given, if the methods of treatment here advocated are thoroughly carried out. Paraplegia is not necessarily a bar to a favourable prognosis.

Deformity of the back will of course remain. To prevent a return of the disease, the patient ought to wear a splint for several years after symptoms of active disease have disappeared.

CHAPTER XII.

SPINA BIFIDA.

Synonyms—*Hydrorachis*; French, *Hydrorachis*; German, *Rückgratswassersucht*; Italian, *Idrorachitide*; Spanish, *Hydrorraquis*.

In this malformation, as already stated in Chap. I., a fissure exists in the arch of one or the arches of several of the vertebræ, and through this opening the membranes of the spinal cord project as a hernia. The sac thus formed is filled with fluid.

The Coverings of the Sac.

The skin may be normal in character or corrugated;[1] but it is more commonly thin and translucent, permitting the contents of the sac to be seen if viewed by means of transmitted light. Or the skin may be altogether absent, exposing the sac.

The sac consists of the membranes of the cord.

The cavity of the sac may be *arachnoidean* or *subarachnoidean*—the latter being the case when the spinal cord or large nerves are involved in the tumour. The cavity may be subarachnoidean, however, and yet no large nerves be present.

The subarachnoidean fluid is serous, with a slight alkaline or neutral reaction, and contains phosphatic and other salts, but little or no albumen.

Grape sugar, or something like it, was shown to be present by MM. Bussy and Deschamps,[2] also by Dr. Turner. Mr. T. Smith obtained the copper test, but no fermentation in one

[1] Prescott Hewitt, *Med. Gazette*, vol. xxxiv.
[2] See *Diseases of Children*, by T. Holmes.

case and no reaction to sugar tests in another. Therefore, if sugar be found in a spina bifida, it may be presumed that the subarachnoidean cavity is involved, and therefore that the cord, or its prolongations, may be present; but, upon the other hand, the absence of sugar is no *certain* proof that the cavity is only arachnoidean.

The presence or absence of portions of the cord, or the corda equina, in the sac is a matter of great importance, as influencing our mode of treatment of the tumour.

Implication of Large Nerves.

Large nerve-cords are often connected with the walls of the sac, but perhaps not quite so often as usually supposed.[1] These cords may pass outwards in the walls of the sac, or may cross the cavity and be connected to the posterior wall. In either case they can usually be detected by means of transmitted light, in the same manner in which the transparency of a hydrocele is examined. The walls of the tumour being generally translucent, the nerve cords, if present, will be detected; but it is possible to mistake old inflammatory adhesions for nerves. When the walls of the sac are not translucent this means of examination will, of course, be useless.

Mr. Prescott Hewitt writes:—'1. If the tumour corresponds to the two or three upper lumbar vertebræ *only*, the cord itself very rarely deviates from its course, and the posterior spinal nerves are generally the only branches which have any connection with the sac. 2. If the tumour occupies partly the lumbar and partly the sacral region, then, generally, the *cord itself* and its nerves will be found intimately connected with the sac.'

The inner surface of the sac generally secretes fluid very actively, and it is possible that this rapid secretion is one of the sources of the hydrocephalus which occasionally accompanies or *follows* spina bifida, for it must be remembered that the sub-

[1] Part of the spinal cord itself has been found in the sac.

arachnoidean cavity of the sac, spinal cord, and brain are usually continuous.

Mr. Hilton,[1] in referring to this connection, and after pointing out the danger which results from drawing off much of the fluid contents of a spina bifida sac, records some cases in which the canal between the medulla and cerebellum has been found closed, one of these being a case of spina bifida. But it is probable that usually there is free communication between the fluid contents of the ventricles of the brain and the fluid of the sac.

Symptoms.—The tumour is 'always in the middle line,' and attached to the bones. The aperture into the spinal canal is usually readily felt. Pressure upon the tumour generally influences the fontanels of the head, causing them to become more tense. Symptoms of the spinal cord or its branches being influenced are frequently present. There may be paralysis of the legs, club-foot, ulcerations of the legs and feet, loss of power in the legs, sphincters, &c., but such symptoms do not necessarily prove that the cord or large nerves are present in the sac or in its walls.

'The progress of the disease is usually to death. As the size of the tumour increases the patient often dies of convulsions, or the skin ulcerates and the tumour bursts; and then palsy or convulsions produce death.'[2]

A few cases are recorded in which the tumour has not increased, except in a corresponding rate with the general growth of the body, and the patients have lived to adult age (one case is reported to have lived until the age of fifty).

In a few very rare cases spontaneous cure has resulted. When this malformation is associated with hydrocephalus, the case is, as Sir Thomas Watson says, 'obviously hopeless.'

Treatment.—As the majority of cases of spina bifida terminate in death if left untreated, operative measures have been

[1] *Lectures on Rest and Pain*, 3rd edition, 1880.

[2] See T. Holmes's *System of Surgery*, 2nd edition.

frequently adopted, notwithstanding the great danger with which such remedies are attended.

Excision of the Sac.

This operation has been performed with some few successes. In performing the operation, the first incisions are made laterally, and the contents of the sac examined, and the operation abandoned if the cord or large nerves are found in connection with the walls. A successful case is reported in France,[1] in which the sac was removed with the écraseur. Of three cases removed by the knife and the opening closed by sutures, by Trowbridge and Dabourg, two were reported to have recovered. Royer and Nott have also tried this plan—unsuccessfully. Dr. Wilson, of Claycross, reports two cases as cured by excision.[2]

In the first operation the tumour was in the dorsal region, and Dr. Wilson tried the effects of compressing the pedicle of the tumour with a clamp previous to operation. When the tumour was removed, the edges of the membranes were touched with a red-hot knitting-needle, and the skin was united with silver sutures. In the second case the tumour was over the last lumbar vertebra. 'The child, two years old, was in a state of great exhaustion, and there was constant discharge from the walls of the sac, which was thin and membranous. The tumour was removed without the use of the clamp.'[3]

Modifications of the plan of excision have been practised, but few successful cases are recorded. When the tumour is attached by a pedicle, ligature of the neck of the sac has been performed; but the results have been generally fatal. Repeated tappings and support with a truss proved successful in two cases treated by Sir Astley Cooper. The treatment caused considerable constitutional disturbance, and a fatal result must have been narrowly escaped; some other cases have been cured

[1] *Bull. de la Soc. de Chir.* 1860.
[2] *Path. Soc. Trans.* vol. xiv. p. 214.
[3] T. Holmes's *System of Surgery*.

by this mode of treatment—Dr. Cabral,[1] for instance, reported such a case—but death of the child has been the usual result.

If the tumour should happen to be pedunculated, it is much more favourable for treatment. The neck may be temporarily obstructed, and then tincture of iodine may be injected without danger. Iodine in solution has been injected into a sessile tumour, with some good results; but it usually sets up such extreme constitutional disturbance from extending into the spinal theca that death results. Velpeau,[2] and Brainard, of Chicago, and others have treated cases by injection of iodine, with some amount of success.[3]

Dr. Morton's Treatment.

Dr. Morton, surgeon to the Glasgow Royal Infirmary, has devised a mode of injection, which is reported to have been so successful both in his own cases and in those of other surgeons, that, judging from these accounts, and from some personal experience in the operation, the author considers that, *when any operation is desirable*, this plan ought to be adopted.

At the same time, it must be admitted that the injection of an irritating fluid, not excepting Dr. Morton's, into the cavity of the spinal column, is at all times a very dangerous proceeding, and one not to be adopted except as an extreme measure.

As some cases of spina bifida have been cured by tapping only, Dr. Morton, very judiciously, recommends this treatment first. The sac is to be half emptied once or twice at intervals of a few days before any of the iodine injection is used. The fluid having been re-secreted, and the cure of the case by tapping thus proved to be improbable, the tumour is to be again half

[1] *British Medical Journal*, March 23, 1872.

[2] See Debout in *Bulletin de la Société de Chirurgie de Paris*, 1860, and T. Holmes, *op. cit.*

[3] Brainard seems to have had three successful cases out of seven, and Velpeau five out of ten. The former drew off some fluid, and supplied its place with a solution of iodine; iodide of potassium 5 grs., and water 1 oz. The solution was then allowed to run out, and some of the original cerebró-spinal fluid was returned.

emptied of its fluid contents, and about half a drachm of the following fluid injected :—

Iodi, gr. x.
Potassii iodidi, ʒss.
Glycerini, ℥j.

The opening is to be immediately closed by lint soaked in collodion.

Some constitutional disturbance usually follows the injection, and in some cases this disturbance is very severe ; it passes off, however, in a few hours. The fluid may partly reaccumulate, but there is usually decided decrease in the size of the tumour in the course of a few days.

Occasionally one injection suffices to cure the case, but more commonly a second and even a third (preceded by removal of some of the fluid contents) is required.

In the experience of Dr. Morton, and several other surgeons who have adopted his mode of treatment, the tumour soon contracts, and the skin becomes hard and corrugated.

For the following illustrations the author is indebted to Dr. Watt, consulting surgeon to the Fever Hospital at Ayr. They show the size of a tumour before and after operation in a case treated by Dr. Watt, upon Dr. Morton's plan. The case was perfectly cured, and the power over micturition and defecation, which had been lost, was 'almost completely' restored.

In answer to enquiries, Dr. Morton kindly wrote to the author as follows :—'Of twenty-nine cases subjected to this operation six have been unsuccessful, leaving twenty-three successful cases,' or 79·31 per cent.

General Considerations with regard to Treatment.

Of the cases of spina bifida which are not interfered with *very few live long*. Of those that live, a few cases of spontaneous cure have been reported, such cure occurring as the result of inflammatory processes, which are probably more dangerous than surgical injection. Of those few who live to adult age the tumour is apt to increase in size, to become

FIG. 109.

FIG. 110.

ulcerated, to be a great inconvenience, to be very sensitive, and to cause periodical or constant nervous irritation in the lower extremities. Therefore, if a child is born with this malformation, a hollow truss should be applied, so made that it will afford a support to the tumour. It may be desirable to keep up a slight pressure upon the parts.

If the results of this treatment are not satisfactory; if symptoms of spinal or cerebral pressure occur, or if the tumour increases in size notwithstanding the truss, an operation should be advised. We have already shown that the operation which has been followed by the best results is that of injection of the iodo-glycerine solution used by Dr. Morton.

It is, perhaps, worth while to remark, that the surgeon cannot be too cautious in representing clearly to the parents of the child the serious nature of the case, and the risks which are attendant upon operation.

False spina bifida may consist of—

1. 'The sacs of true spina bifida, the necks of which have become obliterated.'

2. Congenital tumours.

3. Included fœtal remains.

False spina bifida must be treated on general principles. These tumours may be connected with some of the pelvic viscera. The reader is referred to works on general surgery, especially Mr. Holmes's 'System,' vol. v., p. 809, for further information.

CHAPTER XIII.

RICKETS—INCLUDING KNOCK-KNEE.
OSTEOMALACIA.
OSTEOMATA.

Synonyms—*Rachitis, Morbus Anglicus*; French, *Rachitisme*; German, *Rhachitis*, or *Englische Krankheit*, or *Doppelglieder*; Italian, *Rachitismo*, or *Rachitide*; Spanish, *Raquitis*, or *Raquitismo*.

RICKETS is a constitutional disease, in which nearly every tissue of the body is more or less affected, one notable consequence of the general derangement of the health being the abnormal condition of the bones, which allows them to become deformed.

It is a disease of imperfect nutrition, and is distinct in its nature from scrofula and tuberculosis, as was long since clearly pointed out by Sir W. Jenner.[1] It is essentially a disease of childhood, although some observers say that they have seen it commence at a later period of life.

Billroth is inclined to believe that a species of localised rachitis may occur between the tenth and twentieth years, causing *flat-foot, genu valgum* and *varum*, as well as *lateral curvature* of the spine.

Mikulicz supports this view, as do also Delore, Tripier, and other French writers.

Mr. Chance[2] and some other observers are of opinion that all cases of this disease originate during intra-uterine life—a theory which has been supported by the assertion that the disease is hereditary.[3]

[1] Lectures delivered at the Hospital for Sick Children, Dec. 1859 and Jan. 1860. [2] *Op. cit.*

[3] According to this view, the cases which appear to develop after childhood are those in which the disease has remained dormant up to that period.

Rickets occurs chiefly among the poor, but often among the rich; chiefly in large towns, but also very frequently in the country. The most notable pathological conditions are—

1. Softening of all the bones from a deficiency of their earthy salts.

Children's bones are composed normally of—

Irritant [illegible] phosphorus, lactic acid.

$$\left.\begin{array}{l}\text{Animal matter, 37 parts} \\ \text{Earthy salts, } \quad 63 \quad ,,\end{array}\right\} 100$$

In rachitis these proportions are reversed, and may stand at—

$$\left.\begin{array}{l}\text{Animal matter, 80 parts} \\ \text{Earthy salts, } \quad 20 \quad ,,\end{array}\right\} 100$$

Lehmann and Marchand have found that in some cases the animal matter in rickets afforded no gelatine when boiled.

2. Enlargement of the bones at their junction with cartilage from an excessive preparation for bony formation and an arrest of its completion. This enlargement is especially noticeable in the distal ends of the ulna and radius, and in the sternal ends of the ribs.

3. Thickening of the flat bones.

4. Pathological changes in all parts of the body from defective nutrition.

5. A general arrest of growth.

With regard to the enlargement of the ends of the bones, at the boundary of ossification, the cartilage is found to be very much increased. It has even been seen ten times its normal thickness; and the periosteum is much thickened in all parts, and especially at the junction of the bones with the cartilage. The spongy tissue is very open and filled with red semifluid pulp, formed of blood and nucleated cells. Free fluid fat is also found near the line of ossification.

The soft condition of the bones allows the body to become deformed. Lime salts are insufficiently deposited in the growing extremities of the long bones, and that which is deposited appears in the cartilage cells instead of in the matrix. The lime salts that have been deposited before the disease became active are absorbed and eliminated by the urine.

It has been said, 'Deprive a hen of lime, and she lays eggs with soft shells; deprive a child of lime, and its bones will be soft.' But there is no pathological relationship between the soft shell of the hen deprived of lime and the softened bones of the rickety child. In the former the lime has never been deposited; in other respects the growth is normal. In rickets the lime has been deposited; it is re-absorbed, and then excreted in another place from the blood; and the growth of the bone is abnormal, irrespective of the absence of lime.[1]

Relative frequency of rachitic deformity in different parts of the body in 600 *cases recorded by Mr. Chance.*

In the lower extremities		600
Spurious valgus	28	
Enlargement of the malleoli	300	
Curvature of the tibia and fibula	368	
Knock-knees (in 216 there was also curvature)	396	
Curvature of the femur	142	
In the upper extremity		600
Enlargement of the lower extremity of radius and ulna	600	
Curvature of the radius and ulna	60	
" " humerus	36	
" " clavicle	120	
Curvature (abnormal) of the ribs (narrow or pigeon chest)		156
Spine		108
Deformity of the pelvis		16
" " head		296
Fontanelles, open		400
" closed		200

'The legs are usually deformed to a much greater degree than the arms.'

There may be excurvation of the spine, or the natural curves

[1] Sir W. Jenner, *op. cit.*

of the spine may be increased, or the column may be bent laterally. In children who are carried frequently upon the same arm of the nurse, lateral deflection of the spine is very likely to occur.

The degree of deformity of the spine depends upon the amount of general debility, and is probably usually independent of softness of the vertebræ. Sometimes quite an angular projection is formed in the back, which may be mistaken for a symptom of caries, but may be distinguished from it by extending the child, when the angle will completely disappear if it depends upon rickets. When the vertebræ are soft permanent curves are formed, as in other varieties of lateral curvature.

The femurs, as we have seen, do not often curve much, but they may do so from the weight of the legs, when hanging over the nurse's arms, and in other ways.

The tibiæ and fibulæ curve from the superincumbent weight in walking, or from the child sitting cross-legged, but cases have been seen so soon after birth, that their origin has been considered congenital.

The bones of the arm and forearm curve from the child crawling about and leaning upon them.

The clavicles curve in accordance with the habits of the child, either from the weight of the arm or from pressure when crawling upon the floor or bed.

The deformity which leads to the most serious results is that of the thorax. The ribs bend sharply at their angles, and pass forwards and inwards to the cartilages without forming their natural arch. The cartilages, where they join the ribs, turn sharply backwards, so that a groove is formed from above downwards on each side, just outside the nodes, which are formed where the ribs and cartilages unite.

The sternum projects forwards unnaturally, forming a 'pigeon breast,' and the generally deformed contour of the thorax is rendered more noticeable by slight prominences in the regions of the heart, stomach, and liver, these organs having prevented to some extent the depression of the softened bones.

The deformity of the thorax is produced in the following manner :—At every act of inspiration the action of the diaphragm enlarges the cavity of the thorax in a downward direction.

The effect of this action is to draw air into the lungs through the larynx; but the opening of the larynx is too small to allow the air to enter sufficiently rapidly to fill the space formed, and thus atmospheric pressure is brought to bear upon the sides of the thorax.

In a child affected with rickets this repeated pressure causes the ribs to bend inwards, and their softest parts, viz. where they join the cartilages, are most influenced, and thus the grooves above mentioned are formed.

Sir W. Jenner showed that these changes were thus caused by atmospheric pressure, rather than, as some supposed, by loss of power in the respiratory muscles.

The pressure of the arms upon the sides of the thorax also helps to produce 'pigeon breast.' The pelvis becomes deformed in various directions, thus diminishing its diameters and forming a serious impediment in females, in after life, to parturition; but this condition is comparatively rare.

In the table already given the pelvis was affected only sixteen times in 600 cases.

The deformity of the bones of the head is chiefly the result of arrest of development; and if the disease has existed sufficiently long, the anterior fontanel, instead of being closed at the end of the second year, remains often widely open. The bones are thickened in the neighbourhood of the sutures, but the sutures are indicated by furrows. As in infancy the bones of the cranium are more forward in their development than the bones of the face, the effect of the arrest of development is to cause in the older child an unnatural difference between the face and the head, the former being small in proportion to the latter.

Although the enlargement of the ends of the long bones is so characteristic a symptom of rickets, yet the degree in which it exists is not an exact indication of the degree of softness of the bones, one or other of these conditions being the more marked. The arrest of development occurs in all the bones of the body, and its effects are observable in adult life in a general smallness of the skeleton, and especially in shortness of the long bones; and Mr. Shaw has pointed out that the pelvis and lower limbs are usually relatively smaller than the other bones.

The general arrest of development affects the teeth, their eruption being usually retarded. If a child is late in cutting its teeth, the surgeon should always search for other symptoms of rickets. Other causes may retard the eruption of the teeth, such as a severe illness, but the commonest cause is rickets.

Sir William Jenner points out the importance of this symptom; 'for if,' he says, 'you fail to look for rickets, you will most likely attribute to the irritation of teething symptoms which are the consequence of the rickety diathesis.'

When the ribs are soft, the thorax (under the most favourable circumstances) becomes deformed; but should a lung affection, such as bronchitis, be developed, the consequences are more serious. The increased inspiratory efforts which are made by the patient for the purpose of drawing in air behind the mucus to expel it from the air tubes press in the walls of the thorax, giving rise to collapse of the lungs and death.

Although children affected with rickets are generally emaciated, we often meet with cases in which the body is well supplied with fat; but, when such is the case, there is always an absence of the firmness characteristic of health. The emaciation in rickets is almost always accompanied, and is supposed to be caused, by albuminoid infiltration of the lymphatic glands and spleen, and sometimes of the liver, kidneys, brain, heart, and thymus. The muscles loose their natural firmness, become small, pale, and flabby, but there is no sign of fatty degeneration.

When the disease has ceased, the earthy salts become redeposited in the bones, even to an extreme degree, so that the bones become abnormally thick and strong, and where curved the hollows are filled up with osseous tissue. Sometimes this extreme osseous deposit takes the form of exostoses and bony spicula, the latter occurring especially at the points of insertion of the muscles, or forming ridges, such, for instance, as often appear upon the tibiæ and femora.

The symptoms at first are those of general bad health. The child becomes dull, languid, drowsy, or sleepless. The skin is hot, the appetite is deficient or lost, thirst increases, and the child becomes so weak in its legs as to be unable to move about. The bowels are irregular, the stools unnatural in appearance and very offensive in odour.

At this early stage a wrong diagnosis may be made, and the symptoms are often ascribed to 'irritation of teething,' or even to 'infantile remittent fever.' The diagnosis becomes easier when to the above symptoms are added profuse perspiration of the head, neck, and shoulders, a disposition to throw off the bed clothes at night, and a general tenderness and irritability of the whole body.

The deformation of the bones soon follows the above symptoms. The abdomen usually appears very large. Because—

1. The chest is smaller and the diaphragm more depressed than in health.

2. The liver and spleen are often larger than natural.

3. The capacity of the pelvis is diminished.

4. The muscles of the abdomen and intestines are less powerful than they are in their normal condition; and, moreover, derangement of the digestion is always present to favour the excessive formation of flatus.[1]

Rickety children are deficient in intellectual capacity, although the opposite is so often stated.

The causes of death in cases of rickets may be one or other of the following:—

1. Intensity of the general cachexia.

2. Catarrh and bronchitis.

3. Albuminoid infiltration of organs, especially of the lymphatic glands and spleen.

[1] Sir W. Jenner, *op. cit.*

4. Laryngismus stridulus.
5. Chronic hydrocephalus.
6. Convulsions.
7. Diarrhœa.

Causes.—The general *predisposing cause* of rickets is probably a depression of vital power in the mother.

The Exciting Causes.—Insufficiency of nutrition, whether arising from insufficient quantity of food or from unwholesomeness in quality, bad air, deficient light and warmth, want of cleanliness, and general bad hygienic conditions.

M. Parrot, of Paris, considers that rickets is always caused by syphilis.

That 'at the period when syphilis produces rickets, syphilis has spent itself; it has made its last effort; it exists no longer, but has substituted for itself a new affection.'[1]

One of the arguments M. Parrot advances in support of this theory is, that rickets cannot be produced artificially; but this is contrary to the experience of those surgeons who have seen the disease produced in the lower animals, and, in fact, contrary to the belief and experience of the medical profession generally.

Dr. A. Baginsky, of Berlin, has repeated the experiments of Roloff (also of Berlin) upon animals, and has found that by withholding lime from the food slight rickety changes are produced, but that by adding lactic acid to the food, while the lime salts are also withheld, decided rickets is produced. 'Both factors, the elimination of lime and the addition of lactic acid, have this in common, that they produce an alteration in the general nutrition, the one by withholding an indispensable constituent of the organism, the other by introducing a substance apt to disturb the digestion.'

Dr. Baginsky considers that the reason why the bone lesion is the most prominent symptom is because the 'disturbance of the general nutrition happens at a time when the growth of the bones is most active.'

[1] International Medical Congress in London, August 1881.

Dr. Bouchut, of Paris, contends that the bone changes in both syphilis and rickets are due to faulty nutrition.

General Treatment.—The disordered condition of the digestive organs nearly always demands our attention first, and a saline purgative, or perhaps rhubarb and grey powder (the latter with caution and sparingly), should be administered until the evacuations lose the very offensive character which they usually possess in this disease. Then may follow tonics, steel wine, cod-liver oil, or the syrup of phosphates of iron and lime.

The late dentition, referred to as a very frequent effect of this disease, should receive attention, and care must be taken that the food is suitable in quantity and quality.

Local Treatment.—Every case must be treated according to its individual peculiarities. When the ribs are very soft, it is desirable to prevent the too rapid descent of the diaphragm, and a simple woollen bandage will often effect this object.

A guttapercha splint, lined and attached to the shoulders by armlets, and to the abdomen by a bandage, is an excellent mode of affording support to the weak back (see Chap. X.) Pasteboard or stiffened felt may also be used as a splint, and in either case the abdominal bandage controls that part which is so much inclined to protrude.

With regard to the application of splints to distorted legs, it has been urged that they are liable to do harm. First, by altering the shape of the softened pelvis; secondly, in consequence of their weight, by interfering with the action of the already weakened muscles.

Those who object to splints advise rest alone, and trust to nature to remedy the defects in shape.

The majority of surgeons who have had much experience in treating these cases are, however, in favour of the employment of splints while the bones are in a soft condition.

They support this practice upon the following grounds:—

1. That if the splints are light they do no harm to the pelvis.

2. That by means of carefully regulated pressure the bones may be gradually straightened into a normal position.

3. That when the splints are well applied the children can run about, and obtain the advantages of fresh air and exercise without increasing the crookedness of their bones.

It has been urged that, as the pelvis may be affected, it is desirable to keep the patients from moving about, in order to prevent deformity of that part. This precaution is, of course, especially recommended in the case of girls, because of the subsequent interference with parturition, which such deformity will cause.

This is a very important matter, and requires careful consideration.

In the first place, there can be no doubt that the general health of the patient is a matter of the greatest importance, for if the disease is allowed to progress unchecked, increase of deformity is certain to occur under any conditions of position, and the constitutional state may lead to permanent ill-health, or to death.

Doubtless the disease can be treated with benefit while the patient remains recumbent, and if the disease is very severe, the patient is often unable to move about at all; but, in the majority of cases that come before the surgeon for the treatment of bow-legs and other rachitic deformities, exercise in the open air is a valuable adjunct to other treatment, in so far as the general health is concerned, and it is probable that in this majority the pelvis is not affected.

Mr. Chance, as we have already stated, found the pelvis deformed only sixteen times in six hundred cases; and other observers have remarked, that when the pelvis is affected the other parts of the skeleton are very much deformed.

Therefore we may presume that it is only in the more severe cases that we need fear any distortion of the pelvis; and it is in those severe cases that there could be no doubt as to the necessity of recumbency being maintained.

Acting upon these principles, we are able to treat the children of the poor much more satisfactorily than if recumbency had to be insisted upon in all cases, for the air of the habitations of the majority of the parents of rachitic children would seriously interfere with the good effects of all our medicinal and dietetic remedies.

Furthermore, in dealing with this subject of recumbency, it is worth while, perhaps, to consider the effect of the various positions of the body upon a pelvis softened by rachitis. This we are able to do by referring to Mr. John Wood's elaborate article upon the pelvis in the 'Cyclopædia of Anatomy and Physiology.' There it is shown, as we might suppose, that in the sitting and standing postures the pressure of the weight of the body has a great influence in producing deformity of a softened pelvis; but it is also stated that the recumbent position does not necessarily give immunity from distortion.

In lying *upon the back* the pelvis becomes flattened antero-posteriorly, the commencement of the elliptical pelvic deformity 'which occurs in the majority of the softened pelvis of infants.' 'The angles of the pelvis, with the spine, will also have a tendency in this posture to become *increased* by the weight of the inferior extremities.' The symphysis pubis will sink, and the sacrum become flattened. In lying *upon the side* the lateral pelvic arches yield and bend inwards.

The surgeon should, therefore, be guided in his treatment by the circumstances of the case. In boys the possibility of slight deformity of the pelvis occurring will be a matter of secondary consideration, and the benefits of exercise, when the patient is not too weak to take it, should be recognised.

In girls, if the femurs and spine are unaffected by the disease, it may be presumed that the pelvis is also free. But if the whole frame is soft, locomotion is contra-indicated, and care should be taken by the parents that no one position of recumbency is habitually maintained by the patient.

Treatment of Rachitic Curvatures.

While softness remains, the long bones may generally be restored to a normal shape by carefully regulated pressure; but some extreme cases are very difficult to treat, and sometimes the bones cannot be entirely restored to normal shape.

Curvatures of the Lower Extremities.

The femurs are comparatively seldom curved, and when they are the deformity seldom requires instrumental treatment. The two legs may form a great portion of a circle when the patient stands, and yet the femurs may not be deformed. This fact will be shown if the patient be placed in a sitting posture, and the knees be approximated by crossing the legs, the thighs then assuming a natural position.

It is the tibia and fibula alone that usually require treatment. Simple wooden splints, reaching from an inch above

FIG. 111.

FIG. 112.

the knee joint to the ground, are required. These are to be well padded, and attached by webbing straps to the leg, one ($1\frac{1}{4}$ inch wide) below the knee, and another ($1\frac{1}{4}$ inch wide) at the ankle, and one ($2\frac{1}{4}$ inches wide) opposite the curve.

The legs are to be either first bandaged or covered with a stocking.

This treatment, which is carried out at the City Orthopædic Hospital and by the author at the Farringdon Dispensary, differs from that usually recommended in the following particulars :—

1. The patient is not restricted from running about (an important matter, as already stated).

2. Only one strap, and that a broad one, is used for producing pressure upon the curve. If several straps are used, the pressure is not so effectually applied, and the parents, or those who attend to the case, are more likely to readjust the *one* strap, and so keep up the pressure, than if there were several straps to be attended to.

If the curve is a forward one, the case will be much more difficult to deal with, because—

1. The sharp edge of the tibia will not bear much pressure without the skin being abrased.

2. The tibia being generally much flattened laterally in these cases, the bone does not readily yield.

The advantages which wooden splints possess over irons and other accurately-fitting splints is—

1. That as the child moves about the splint moves slightly also, and thus *one* place is not continually pressed upon, and so abrasions are not produced.

2. Directly the splints become loose from reduction of the curves, the fact is plainly observable, and the necessity for tightening the straps is apparent; whereas irons will appear neat and in place, although the straps which are meant to act upon the deformity may be quite loose, and the instruments consequently doing no good.

The question has often been raised as to the necessity of treatment by splints in all cases of rachitic curvatures; and it is often asserted that children will 'grow out' of these deformities; but such an assertion is only correct in a very limited sense.

If the softness of the bones exists for a very short time, or the child is prevented from using its legs (the curves being very slight), children may possibly 'grow out' of the deformity; but it is probable that this result is more apparent than real. A curve that is just noticeable when the legs are short, if it does not increase, becomes obscured when the legs get longer. But such favourable result depends upon an early arrest of the disease.

In order to form an idea of the ultimate result of crooked legs upon that portion of the community who, as children, suffer most often from rachitic curvatures, namely, the labouring and artisan classes, a series of observations have been made by the author upon a number of individuals of these classes, with the following results :—

1880.							
Aug. 20.	Observed	67	individuals, of whom the legs were straight in	24	and crooked	in	43
22.	"	45	" "	20	"	"	25
24.	"	76	" "	26	"	"	50
25.	"	21	" "	6	"	"	15
31.	"	54	" "	16	"	"	38
Oct. —	"	39	" "	10	"	"	29
22.	"	36	" "	9	"	"	27
24.	"	32	" "	10	"	"	22
—	"	48	" "	18	"	"	30
Dec. 5.	"	64	" "	21	"	"	43
		482		160			322

Individually and collectively these statistics show that among the classes indicated we find a proportion of about two persons with crooked legs to every one with straight legs. This will probably be admitted to be a very remarkable result, but one which anyone can determine for himself. We have no record to show the proportion of *children* who suffer from these deformities in comparison with those who do not; but it can hardly be a much larger proportion than two to one. Out of the number of children affected a certain proportion are cured under treatment, so that to produce the above statistics the proportion who 'grow out' of their crooked legs must be very small indeed.

When curvatures of the bones have become fixed by consolidation of the bones, the only remedy which can be employed is either osteotomy or fracture of the bone and re-setting in a normal position.

For the treatment of lateral curvature, the result of rickets, see Chapter X.

Genu Valgum.

Synonyms — *Knock-knee, In-knee*; German, *Einwärts gebogene Knieen.*

This deformity, although not always a result of rachitis, is so often associated with or produced by that disease, that it is desirable to deal with it in this place.

Knock-knee is said to exist when, if the legs are extended upon the thighs to the fullest extent, and the knees of the two legs made to touch, the feet remain more or less separated from one another, the deformity existing at or about the knee joint. When examined, the patient should be in a sitting position facing the surgeon.

Pathological Anatomy.

The condition of the parts differs in different cases. Some recent writers upon this deformity have described the internal condyle of the femur as occupying a lower level than the external. To explain this abnormal position many observers have stated that the internal condyle is overgrown,[1] and that the epiphysary cartilage is also in excess.

Mikulicz,[2] who has examined thirteen morbid specimens, and confirmed the results of these examinations by clinical observations, states that he has not found the condyles altered in any of them, but that, when the internal condyle projects downwards, it is caused by a bending outwards of the lower extremity of the diaphysis of the bone. The tibia is also bent in the same way, and sometimes to a very great degree.

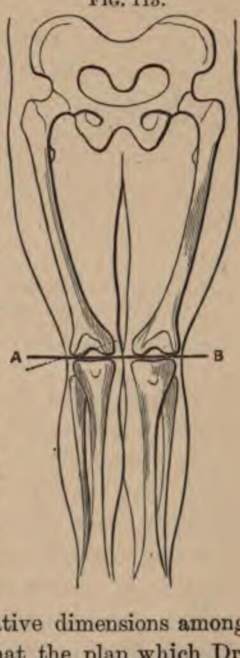
[1] MM. Ollier and Tripier.

[2] *Archiv für Klinische Chirurgie von Langenbeck,* Band xxiii. 1879.

Macewen,[1] in support of the statement that the condyle is elongated, quotes the statistics of Dr. Clark, Lecturer on Anatomy at the Royal Infirmary, Glasgow, according to which the internal condyle is normally longer than the external by a quarter of an inch; and Macewen states that in 70 per cent. of his own cases the quarter of an inch was exceeded. He also found an inward increase of the condyle in some cases, and in all he considers that the most important factor in the condition is an internal curve of the lower third of the femur, with its consequent twisting outward of the condyles.

The author had examined over fifty consecutive cases in the living subject upon a different principle to that described by others, and in these cases he had found the tibia more at fault than the femur.

Fig. 113.



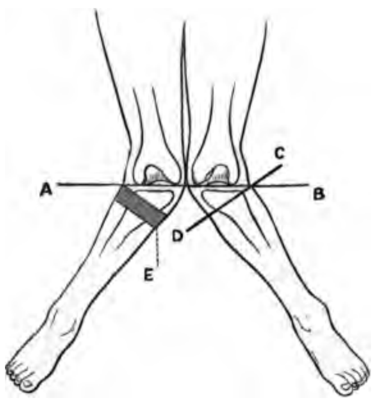
If an individual whose form is normal stands upright, with his legs in juxtaposition, the surfaces of the condyles will be level with each other and parallel with the ground, as shown by the line A B in the accompanying figure.

The exact excess of the length of the internal over the external condyle will depend upon the angle which the femur forms with the parallel line A B, and that angle will depend upon the width of the pelvis and the length of the femur. The dimensions of the pelvis and femora vary considerably, not only between the male and female, but between individuals of both sexes; and there must be a great diversity of relative dimensions among children. Therefore, it would seem that the plan which Dr. Macewen depends upon is scarcely a satisfactory one.

[1] *Osteotomy*, London, 1880.

In order to determine whether the femoral articular surfaces are level, the knees of the patient should be placed in juxtaposition, the thighs being kept evenly placed with regard to the body (i.e. not one abducted and the other adducted); then a rule being placed across the knees, the normal or abnormal condition of the level of the condyles can be discovered.

FIG. 114.



Sketch to show the usual deformities of the bones in Genu Valgum. A, B is a horizontal line, showing the horizontal position of the articular surfaces of the femora. C, D is a line drawn at right angles to the long axis of the tibia, showing the enlargement of the internal tuberosity. Upon the right leg is placed a tape E, as described in the text.

With regard to the *condition of the head of the tibia,* a tape may be placed round the leg, level with the border of the external tuberosity, and at right angles to the long axis of the tibia. The height of the articular edge of the internal tuberosity above the tape indicates the excess of size of this tuberosity over the external. If the tibia is partially dislocated outwards by disease or accident, and remains long in that position, the knee becomes deformed in a similar manner to ordinary genu valgum. In these cases, however, the internal condyle of the femur is entirely relieved from pressure, and it becomes elongated.

The opinion held by many surgeons, that the deformity in all cases of knock-knee exists chiefly or entirely in the femur, and that the tibia remains normal in shape, is often based upon the circumstance that the deformity disappears when the legs are flexed. They believe that by flexion the articular surface of the tibia is removed from the influence of the downward projection of the internal condyle of the femur.

Gerard, arguing upon this theory, explains this result of flexion by *supposing* that the posterior part of the internal condyle of the femur is less prominent, or that the posterior aspect of the *external* condyle is more prominent than the internal.

This difference in the condyles, however, did not exist in the cases examined by Mikulicz; and, moreover, the disappearance of the deformity upon flexion of the legs will be found to depend chiefly or entirely upon rotation of the femur at the hip joint; and Mikulicz describes a rotation of the leg as well as of the thigh, varying according to the bone (femur or tibia) which is chiefly or only involved in the deformity. Mikulicz further describes an abnormal smallness in the diameter of the shafts of the femur and tibia. The fibula is not usually bent. The external condyle may be flattened from the front, and the joint surface is very often widened. Although it has been often asserted that the articular cartilage is atrophied upon the outer part of the joint, Mikulicz has found its thickness here increased, and the cartilages upon the inner half of the joint decreased in thickness, which facts accord with the theory that increase of pressure favours increased growth of cartilage.

With regard to the ligaments, the same observer has found the internal lateral ligament hypertrophied and tense, but not lengthened, except in cases where the whole joint has been loose; and Linhart appears to have made the same observation, and also found that the external lateral ligament was unusually long. But the external lateral ligament is more frequently really shortened, although it may be long for the altered position of the articular surfaces.

The patella is sometimes luxated outwards.

Causes of Genu Valgum.

These are *predisposing* and *exciting*.

Predisposing Causes.—Genu valgum is so often associated with rickets that it has been considered recently by some surgeons as entirely a result of that disease. There seems to be no doubt that rickets may produce an unequal development of the bones, which causes a slight degree of genu valgum independently of any other condition. Such, probably, is the case when this deformity is found in infants who have never used their legs; and it may be therefore presumed that the same influence may act in children in whom genu valgum commences after the weight of the body has been brought to bear upon the lower extremities. But genu valgum may occur in individuals unaffected by rickets.

Rickets produces softness of the bones and weakness of the structures which should support the joints; and such conditions are very favourable to the production of this deformity. Similar or nearly allied conditions may arise from deficient nutrition, fever, and other depressing illnesses, and from rapid growth. It may be the result of diseases or traumatic injuries of the joints.

Mikulicz describes the general thickening of the epiphysial cartilage and other characters which denote the existence of rickets in the cases which he examined. He, moreover, found the epiphysial cartilage thicker towards the internal border of the leg; and this thickening was probably the result of the deformity. The opinion of Billroth and others, that a species of rickets may occur between the ages of ten and twenty, and give rise to genu valgum and other deformities, has already been referred to.

When the deformity exists at birth, or develops in children before they have commenced to use their legs, the cause cannot be pressure from the superincumbent weight; and so there must be either some abnormal development of the bones or contraction of the muscles and ligaments.

The bones in genu valgum are always abnormal in form, but the muscles and ligaments are very rarely contracted, and are probably only so as results of the deformity. The abnormal condition of the joint also frequently prevents complete extension of the leg upon the thigh, and thus a cause of difficulty in treatment may arise.

In a certain proportion of cases (probably in the majority) weakness of the structures is the predisposing cause. It remains for us to consider the exciting causes of this deformity.

Although, in the normally constructed skeleton, the weight of the body is transmitted through the centre of the knee joint in the simple position of standing, yet there is a much greater tendency for the weight to be thrown upon the external portion of the joint than upon the internal. In standing carelessly, for instance, one leg is apt to receive more pressure upon the outer side, and be inclined inwards at the joint. In those trades which necessitate much standing, the legs are frequently placed so that the joint is strained towards the perpendicular mesial line of the body; and it is among youths who are employed in such trades that we oftenest meet with this deformity. But occupations which necessitate standing are probably not often alone likely to cause the deformity, and Mikulicz has pointed out that close damp air and insufficient food are probably important factors in its production.

Bakers and factory boys, who very frequently suffer, are especially subject to these unhygienic conditions.

Mr. Edmund Owen[1] has referred to the greater strength of the ligaments, bands of fasciæ, and muscle tendon upon the outer side of the joint, in comparison with those upon the inner side; and these structures doubtless exercise an influence in preventing a weak joint from giving way in an outward direction, but, as we have seen, the tendency is for the joint to give way inwardly.

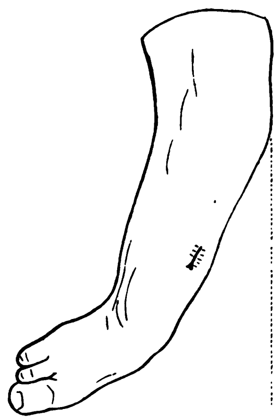
[1] *Journal of Anatomy and Physiology*, vol. xiii. 1878.

Flat-foot is often stated to be the cause, and for the following reasons :—

The arch of the foot being flattened, the foot becomes everted, the inner malleolus is lowered towards the ground, and the lower end of the tibia is inclined outwards, and so the weight of the body is thrown unduly upon the side of the limb (Brodhurst).

As the same weakness of the tissues predisposes the individual to both knock-knee and to flat-foot, it is not surprising that we frequently find these two conditions coexistent. Either of the deformities may have commenced first; but if the flat-foot

FIG. 115.



Outline of an Infant's Leg with Congenital Genu Valgum. (After E. J. Chance.)

The tibia and fibula in the lower third were (congenitally) curved outwards. It will be observed that there were only three toes.

has been the first to be formed, it would be an exciting cause of knock-knee. It is possible for the flat-foot to be a result of the knock-knee, or both deformities may develop simultaneously. Moreover, knock-knee is frequently met with without coexisting flat-foot.

Flat-foot may be a matter of appearance, in consequence of the position given to the foot by the knee deformity.

In some cases a condition of varus exists which is probably caused by the oblique position of the leg inducing the patient to endeavour to adapt the foot more naturally to the surface of the ground.

The various opinions upon these points have arisen probably from individual observers basing their views upon the study of particular classes of cases.

It has already been mentioned, that in young children cases frequently occur quite independently of the pressure from the weight of the body; and in these cases we cannot separate the causes into predisposing and exciting. But yet, whatever may have been the cause that acted in the first place, there can be no doubt that locomotion greatly increases the deformity.

Other views are advocated, or have been advocated, upon the exciting causes of this deformity, as follows:—

1. Muscular contraction of the biceps alone, or with fibrous retraction of the external lateral ligament and shortening of the fascia lata (Jörg, Duchenne, Guérin, &c.)

2. Inward curve of the lower third part of the femur, and consequent twisting out of the condyles and abnormal elongation of the internal condyle as a primary origin (Macewen).[1]

3. Relaxation of the internal lateral ligament (Malgaigne, Stromeyer, &c.)

4. Premature union of the external half of the epiphysis (Gosselin, &c.)

5. A condition of hyperextension of the legs upon the thighs, increasing the normal degree of rotation of the tibia outwards, at the termination of extension in rickety subjects (Mikulicz).

Whatever may be the exciting cause, or whatever may have begun the deformity, inequality of the pressure of the superincumbent weight is the power by which the abnormal condition of the parts is increased. Pressure being excessive between the articular surfaces of the outer part of the joint, the growth is there retarded. Pressure being relieved at the

[1] *Osteotomy*, by William Macewen, M.D., London, 1880.

inner part of the joint, growth is unrestrained.[1] The natural result of this unequal pressure is the deformity of the bones constituting knock-knee.

When the deformity occurs as the result of traumatic injuries, such as unreduced dislocation of the patella outwards, it is then also produced by unequal pressure.

Knock-knee may occur from inequality in the length of the legs, the longest having to be bent outwards, inequality of pressure being thus produced.

Slight knock-knee having once formed, will continue to increase if not treated; and the tendency to increase becomes stronger as the deformity progresses. In severe cases the patient's style of progression becomes very peculiar. In order to bring the feet nearer to one another the legs are flexed upon the thighs, so that a crouching attitude is assumed. In standing, the knees are often crossed. The patellæ are sometimes drawn outwards.

Treatment.

The following plans of treatment have to be discussed :—

1. Hueter's method.
2. Gradual reduction by means of instruments.
3. Gradual reduction by means of manual stretching and retention in plaster of Paris bandages; repeated at intervals.
4. Tenotomy and division of ligaments, followed by the use of instruments.
5. Sudden reduction by means of violent force: Delore's method.
6. Reduction by the osteoclast.
7. Osteotomy.

1. *Hueter's plan* of retaining the leg in a semi-flexed position by plaster of Paris bandage is based upon the supposition that hyperextension is the cause of the development of knock-knee. He states that, by preventing this hyperextension, the bones will right themselves by growth. The plan has been tried

[1] See Chiene upon 'Genu Valgum,' *Edin. Med. Journal*, April 1879.

in Germany by Mikulicz, König, and Waitz, but no good results followed; and the author cannot understand how any beneficial action could be expected to occur, as no means are used to redress the existing deformity. Moreover, the theory is not consistent with facts, because in this deformity not only is hyper-extension not always present, but the leg frequently cannot be fully extended—a condition which presents one of the chief and most frequent obstacles to the proper adaptation of instruments.

2. *Gradual reduction by means of instruments.*

A great variety of apparatuses have been used for this purpose, many of which are objectionable, upon one or more of the following grounds:—

(1) Their clumsiness.

(2) Their use necessitating the recumbent position being maintained by the patient during the period of treatment.

(3) Allowing rotation of the limbs inside the instruments.

(4) Causing excoriations and looseness of the ligaments.

All these evils may be avoided if the patients are treated by means of the splints or apparatus, and in the manner to be presently described.

The treatment of genu valgum by means of splints or instruments is necessarily a very tedious process, and one which is only thoroughly effectual when employed at a time before the bones have become consolidated. But, although slow, the process is free from the dangers which belong to forcible reduction and to osteotomy. If used in suitable cases, and if conducted with due care, the result is always satisfactory. Moreover, with regard to the time occupied in treatment, in the case of young children whose bones are rachitic the gradual mechanical reduction will not occupy a much longer period than will the treatment by osteotomy, because in the latter case some retentive apparatus must be worn by the patient, so long as the bones are soft.

By means of osteotomy cases are said to be perfectly cured in about two months from the commencement of the treatment;

but we know that many cases of relapse occur when they are thus left without any supporting apparatus.

However, it must be remarked in favour of the osteotomy that the supporting apparatus admits of flexion of the leg, whereas the splints, and apparatus for gradual reduction treatment, necessitate a constantly straight position of the leg.

In comparing these two plans of treatment, however, their comparative danger is a much more important point for consideration than the length of time which they individually require.

Osteotomy is occasionally followed by disastrous results. Even when strict antiseptic precautions are adopted, the possibility of suppuration and septicæmia, and the consequent loss of life or limb, or permanent damage to the health of the patient, render it necessary for us to place this mode of treatment in a very different category from that of gradual reduction.

The next point for consideration is the limit of age at which gradual reduction may be effectual.

No precise age can be determined.

Cases differ considerably, but up to ten or twelve years every child, or nearly every child, can be cured by means of splints or instruments, and many can be thus cured who are older.

The deformity has been known, in fact, to be removed in some individuals by such treatment at the age of twenty and twenty-one years.

The gradual reduction treatment has failed in the hands of many surgeons, and probably in consequence of the manner in which the process has been carried out.

The use of the legs is frequently forbidden, and in fact many modes of treatment by apparatus necessitate constant recumbency. Such a plan is detrimental to the general health in rachitic and other cases, and in *moderately severe cases* it retards the cure.

In the same way that unequal pressure produced the deformity, so slight unequal pressure (set up in the opposite direction by the apparatus) will remove it. Therefore, exercise becomes an important factor in the treatment, for if the instrument be frequently altered, so as to keep up a constant *slight* inequality of pressure upon the joint surfaces, the deformity will be slowly but surely removed. The same process of encouraged growth upon the one side and retarded growth upon the other, which took place during the production of the deformity, now acts in the contrary direction.

There are, however, some severe cases in which locomotion is either impossible or so difficult that confinement in the recumbent position becomes desirable, under which circumstances pressure upon the deformity must be made rather more strongly, and be very carefully regulated.

The treatment is often interrupted by the production of sores. Such accidents are either caused by the pressure being applied too severely, or from elastic pressure being used. No sore will occur if the pressure is made by means of webbing straps, or by leather knee-caps applied in the proper place, and never sufficiently tight to leave the patient in pain.

Stiffness of the joints after treatment has been stated to occur, and is urged as an objection to gradual reduction, but such a result has not been observed in the cases treated in the manner to be presently described. Passive movements of the leg upon the thigh, moreover, if practised every few days, would quite prevent the possibility of any stiffness occurring.

Interruption of the patient's work during the period of treatment is very rarely necessary, and can only occur when very active movements are required. Patients soon learn to walk well, notwithstanding that flexion is prevented; and when the legs have been brought into a straight or nearly straight position, close observation is often necessary to detect any peculiarity of gait, and trousers will hide the apparatus.

Relaxation of ligaments is especially referred to by Mikulicz as occurring after treatment by his own and by Hofrath Billroth's apparatus, and seem to have been caused by very strong pressure.

Details of the Treatment by Gradual Reduction.[1]—If the child is small, and the deformity is slight, straight wooden splints will suffice. These should extend from the pelvis to the ground, should be well padded and attached by a webbing strap at the ankle $1\frac{1}{4}$ inch broad, and a strap at the knee $2\frac{1}{4}$ inches broad, the latter to reach to the top of the prominence of the internal condyle of the femur.

Fig. 117.

Fig. 116.

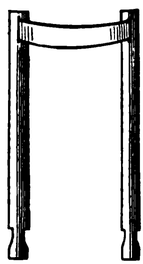


Fig. 116 represents the splints, which are attached at the top by a band. Fig. 117 represents the splints applied.

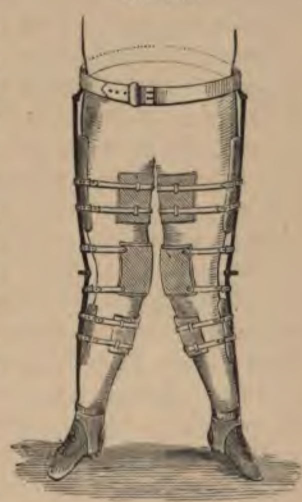
The upper extremities of the splints should be connected by a strap passing over the buttocks, but the pelvis should not be encircled. The legs should have been first bandaged, to prevent the straps injuring the skin, or stockings should be worn. If the case is a severe one, such simple splints will not keep in their place, and it becomes necessary to employ an instrument made upon the following plan: a pelvic belt, side bars of

[1] As carried out at the City Orthopædic Hospital and at the Farringdon Dispensary.

steel, with cog-wheel joints at the knee and free joints at the waist and ankles; thigh straps, leg straps, and knee caps. This apparatus can be made comparatively light.

Pressure upon the knees should be kept up constantly, by frequently tightening the webbing straps, or by turning the joint in the instrument; but this pressure should never be sufficient to cause pain, and it should not be relaxed at night. The rapidity of the cure will depend upon the frequency and persistency with which the pressure is applied; and the longer the instruments are worn after the legs are straight the greater certainty will there be of a permanently good result.

FIG. 118.



If the bones of the legs are curved, the lower part of the instruments can be brought to the inner side of the leg, and be used to form a basis from which to bring pressure to bear upon the curve.

One great and important advantage claimed for this treatment over all others is that the patient is never 'laid up' for a single day. He can fulfil many occupations without difficulty, and the instrument he is wearing may be effectually hidden from sight. In those severe cases in which, *without apparatus*, locomotion is impossible, effectual pressure upon the internal parts of the joint surfaces cannot be accomplished if the patient attempts to walk *with* an instrument, and therefore confinement to bed becomes a desirable adjunct to treatment.

3. *Gradual reduction by means of manual stretching and retention in plaster of Paris bandages; repeated at intervals.*

To produce the pressure gradually with much effect the bandages would have to be renewed every few days. But it seems that the process has often (or perhaps generally) induced the surgeon to use more force than is desirable, sometimes approaching a *redressement forcé*.

The plan cannot be recommended by the author, because splints or instruments can be managed with more safety and with much greater accuracy.

4. *Tenotomy, and the division of ligaments and fasciæ, followed by the use of instrumental support.*

As a universal remedy for all cases of genu valgum this treatment is neither necessary nor desirable. After the operation the leg is brought into or approaching a straight position by producing a wedge-shaped gap between the articular surfaces, and when the leg is retained in that position the pressure of the body is brought to bear upon the internal edge of the joint surfaces. The reduction is not sufficiently gradual for the bones to adapt themselves satisfactorily to the alteration. And, if the external lateral ligament is divided, the strength of the joint at this aspect will probably remain deficient. However, some extremely severe cases do occasionally occur in which the biceps muscle, from long-continued position, has become so short that tenotomy may possibly be necessary; in which case the operation should be conducted as follows:—

Division of the Tendon of the Biceps.—Care must be taken not to injure the peroneal nerve, an accident which has proved very troublesome in its effects. The knife should be passed beneath the tendon from the inner side, and should be introduced with its flat surface parallel with the tendon. The cutting edge should then be turned towards the surface, and the tendon divided in the manner described under *club-foot*. When the tendon is cut the peroneal nerve becomes prominent, and feels very much like a tendon. The after treatment should be carried out upon the same principles as recommended for tenotomy in cases of club-foot.

5. *Sudden reduction by means of violent force.*

Redressement forcé (Delore's method) consists in forcibly bending the limb into a straight position, and so retaining it by a plaster of Paris bandage for three or four weeks. Upon the bandage being removed, if necessary, a further operation is performed, and another bandage applied for a like period, at the end of which time the patients are said to be cured. Sometimes, however, a supporting apparatus has to be worn for many months or permanently.

Delore places the patient upon his side, the leg to be operated upon being next to the table. The ankle is fixed by an assistant, and rests on the table. The upper fixed point is the trochanter. The correction of the deformity is attained by several shocks (*petites secousses*). Mikulicz thinks it would be better to perform reduction, if possible, by one sudden effort.

The results upon the tissues of this severe treatment have been demonstrated by Barbier,[1] by experiments on the dead body. He produced injuries to the epiphysial lines of the femur and tibia, ruptures of the periosteum, and frequently laceration of the external lateral ligament. Delore [2] describes the condition of the parts in a child whose knee he was enabled to examine twenty-one days after the performance of his operation, and he found that the articular surfaces upon the outer side of the joint were not in apposition. He also admits that the reduction is often effected at the expense of the ligaments. Mikulicz, who is in favour of this means of treatment in *young children* only, remarks that these evils only occur when the period of childhood is passed.

If *redressement forcé* is ever desirable, it can only be so in young rachitic children whose bones are very soft; but, in the author's opinion, the possibility of interfering with the development of the epiphysis by injury and of setting up an injurious degree of inflammation or of rupturing the ligaments, is a very good reason for avoiding so violent a mode of treatment. Moreover the treatment of the affection in young children who

[1] *Etude sur le Genu Valgum.* Thèse. Paris, 1874.

[2] 'Du Genou en dedans, de son mécanisme et de son traitement par le décollement des Epiphyses,' *Gaz. des Hôp.* 1874.

possess soft bones can always be accomplished by the more simple and safe means described above.

With regard to the adoption of this treatment in other than young rachitic patients, the records of cases treated by the *redressement forcé* method (and the author is glad to say that he has no personal experience of the operation) show many very disastrous results. In the most favourable cases the external lateral ligament was ruptured, and in others the subsequent pain, permanent weakness, and partial or complete loss of use of the limbs, show that this procedure is an unjustifiable operation.

6. *Reduction by means of Rizzoli's osteoclast.*

This operation is not suitable for *genu valgum*, because the fracture must be made at a distance from the seat of deformity in the bone. But it has been recommended for outward curved tibia, for which it might sometimes be suitable. By this means a simple fracture is produced, which runs its course without complication.

7. *Osteotomy.*

The subcutaneous division of bones, and their readjustment in improved positions, if performed with every possible precaution to prevent septicæmia, is an operation which can now be carried out with a very small percentage of bad results. Nevertheless it is a serious operation, and one which ought not to be performed if a safer means of treatment is available, nor without thoroughly explaining to the patient its nature and risks.

Loss of limb, health, and even loss of life occasionally results from this procedure.

To perform osteotomy upon cases that can be cured by more simple means is contrary to sound surgical principles; and the frequent performance, during the last few years, of this operation upon children between four and twelve years of age, has called forth very strong condemnatory expressions from many surgeons of high repute.

Up to about twelve years of age, and even beyond this period, simple curvatures and genu valgum may be nearly always cured by pressure alone; and we have already alluded to the softness of the bones which sometimes occurs at about the time of puberty, and may still exist at the age of about twenty.

When the bones have become consolidated, then osteotomy or osteoclasis is the only means by which we can remedy severe cases of this deformity.

We have already discussed the latter operation, and said that it may be suitable for fixed rachitic curves of the leg bones, but for genu valgum the fracture cannot be made sufficiently near to the joint to be quite satisfactory in its results.

Osteotomy for Genu Valgum.—The various modes of performing this operation are—

1. Separation of the internal condyle of the femur from the rest of the bone, and displacement of the fragment upwards.

2. Section of the upper end of the tibia, and in some cases of the fibula also.

3. Section of the femur.

I. *Interarticular Osteotomy.*—Ogston's operation,[1] and its modifications, by Reeves and others.

The internal condyle of the femur is removed either by the saw or the chisel and displaced upwards, a proceeding which necessarily opens the joint. Mr. Reeves professes not to penetrate quite into the joint, but to leave a small portion of bone at the base of the condyle, which is broken through after the chisel has been withdrawn. The result in all cases is, however, practically very similar.

This is a very serious operation. The fatal and other disastrous results by which it has been followed ought to be sufficient reasons for its abandonment. It is, moreover, quite contra-indicated in those cases in which the deformity depends wholly or chiefly upon an abnormal shape of the tibia, and, in the author's experience, it is the tibia which is nearly always at fault (see p. 253).

[1] See discussion at the Medical Congress at Berlin in 1878, of which an epitome is to be found in the *London Medical Record*, June 15, 1878.

Division of the bone has been accomplished by one or other of the following means:—

1. By piercing the bone with a gimlet in several places and then fracturing the remaining bone.
2. By means of a narrow-bladed straight saw.
3. With a chain saw.
4. With trephines; or
5. With a chisel and mallet.

The principles of subcutaneous section are usually aimed at; but the nature of the operation hardly permits the total exclusion of air.

Strict antiseptic precautions, as advocated by Lister, are said by some operators to make osteotomy safe and certain; but cases have been recorded which show that, notwithstanding great care in employing Lister's method, unfavourable results may occur.[1]

Operators differ in opinion as to the comparative merits of the saw and chisel. The former instrument is more easily controlled, but it produces debris which may act as a source of irritation.

II. Meyer's operation—division of the tibia below the tuberosity—is performed by means of the chisel and mallet from the anterior aspect. If the deformity is very severe, and the division of the tibia does not allow a sufficient degree of reduction, then the fibula is divided also. The deformity, if severe, is not to be entirely removed at the time of operation, but is to be corrected two or three weeks later. After hæmorrhage has ceased, the wound is to be closed, an antiseptic bandage applied, and the limb fixed.

After the wound has healed, a plaster of Paris bandage is applied, reaching from the toes to the upper part of the thigh. This casing is removed (if any further reduction of the deformity is required) in two weeks, and, after manual reduction, another plaster bandage is applied, which is left on for from

[1] See a paper read before the Chemical Soc. Nov. 8, 1878, by A. E. Barker, and published in *Clin. Soc. Trans.* vol. xii.

four to six weeks longer. The patient then leaves his bed with or without a supporting apparatus.

III. Macewen,[1] who operates chiefly upon the femur, has well described the necessary details of the procedure. Several of the fatal results of osteotomy he attributes to the use of unsuitable chisels, some breaking in the bone, and others not taking a straight direction because they were only bevelled on one side.

Two forms of instruments are necessary: one shaped like a carpenter's chisel, and used for cutting out wedges from the bone, and the other formed with an edge bevelled upon both sides, for cutting straight through the bone. The latter is called the 'osteotome.' These instruments have to be carefully tempered to suit the material they are intended to cut.

The osteotome is marked upon one edge in half-inches, so that the operator may judge how far he has penetrated.

In operating upon large and very dense bones several osteotomes should be employed. The thickest instrument is to be used for cutting the first third of the bone; one of medium thickness is to follow, and, if necessary, a third finer osteotome is to be employed for completing the operation. In softer bones, the two last-mentioned osteotomes will suffice, or the operation may even be performed with one instrument of medium thickness.

Details of the Operation.—The patient having been placed under the influence of an anæsthetic, the limb is to be made bloodless. A sand pillow will be found a useful basis of support to the limb to resist the concussion of the mallet in the operation. A clean incision is to be made with the scalpel down to the bone, in the direction of the fibres of the muscles to be cut through, and is to be made half an inch in front of the tendon of the adductor longus and about an inch above the condyles. The incision need not be more than half an inch or an inch in length. The exact size depends upon the width of the osteotome to be used. When, however, a wedge of bone is to be cut away, the incision must be longer. The scalpel is used as a director to

[1] *Osteotomy.* By William Macewen, M.D. London, 1880.

the osteotome. When the latter has reached the bone, it is turned into the position in which it is desired to cut the bone.

If a wedge is to be removed, the chisel should be used, and, as with ordinary chiselling, the bevelled side is to be placed towards the part to be removed. If a large wedge is to be taken away, it should be chipped away in several pieces. Neither chisel nor osteotome should ever be used as a lever. The periosteum should be avoided as much as possible, and the bone need not be quite cut through, fracture of the remaining piece being readily effected. The bone having been adjusted in a corrected position, the subsequent treatment is to be carried out as in a case of simple fracture. The necessity of subsequent mechanical support has already been discussed.

Osteomalacia.

In this disease the bones soften to an extraordinary degree. It occurs only in adults, and is considered by pathologists as closely allied to caries (Billroth). It has been called *fungous fatty osteomyelitis*. The disease appears, like goitre, to be endemic in certain districts. In Europe, osteomalacia is not uncommon in Germany near Bonn on the Rhine. In Italy, the neighbourhood of Milan is well known as an osteomalacic district (Fancourt Barnes).

There is an absorption of the earthy salts; the medulla enlarges at the expense of the hard part, until the periosteum is reached.

Little is known about the cause or causes of this disease. It occurs in women more often than in men, and is frequently associated with pregnancy.

Treatment.—Recovery sometimes appears to take place spontaneously, or as the result of treatment upon general principles. The surgeon should support the body and limbs, so as to prevent, as much as possible, deformity and fractures. Some mechanical apparatus might perhaps be beneficial in the early stages, but strict recumbency will be necessary when the disease becomes more advanced.

Osteomata.

Osseous growths may occur as—

1. Spongy exostoses.
2. Ivory exostoses.
3. Ossification of tendons, fasciæ, and muscles.

1. Spongy exostoses almost always occur upon the epiphyses of long bones; they are covered with cartilage. Joints are often involved, and other important parts of the body are occasionally encroached upon by these growths.

2. Ivory exostoses are, as their name implies, of much harder consistence than the foregoing. They are rarely found in connection with other bones than those of the skull.

3. Ossification of tendons, fasciæ, and muscles. This remarkable disease consists in a tendency to the formation of bone in various parts of the body. The movements of the individual usually become more or less restricted. In the museum of the Royal College of Surgeons may be seen a skeleton which exhibits this peculiar affection in a marked degree.

Treatment.—If the osseous growth does not cause much inconvenience to the patient, and is not enlarging, it is advisable to avoid operative interference, for removal of such a tumour is not without danger. If, in consequence of an encroachment upon important structures, or of serious interference with the movements of a joint, or for other reasons, it is considered desirable to remove the growth, the following points should be considered:—

That the larger the basis of attachment, the more difficult and dangerous is the operation.

That in some cases the tumour is in close proximity to or even surrounds some important vessel or nerve—as, for instance, in the case of a bony process surrounding the brachial artery, when that vessel assumes the position which it occupies in some of the carnivora. In such cases an operation is usually contra-indicated.

That if the tumour is an ivory exostosis, its extreme hardness presents a serious obstacle to the chisel or saw of the operator.

That if the growth is situated close to a joint, an abnormal elongation of the synovial pouch may be adherent to it, and an operation will then open the joint.

In performing the operation of removal, the base of the tumour must be thoroughly exposed, and a well-tempered chisel, saw, trephine, or bone forceps may be used to cut through the bone. In the case of ivory exostosis, the late Mr. Keate failed to remove the tumour by such means, and he was obliged to resort to the tedious process of dissolving away the base of the tumour with caustics.[1]

Ivory exostoses sometimes grow from the posterior wall of the external meatus of the ear, causing in time almost complete deafness.

Mr. George Field, aural surgeon to St. Mary's Hospital, has operated successfully in several cases of this kind. He penetrates the tumour by using various forms of drills. This plan might be advantageously adopted in dealing with these growths in other regions.

The Treatment of Ossification of Tendons and Muscles.—A severe case that was treated by Mr. Cæsar Hawkins at St. George's Hospital was temporarily benefited by blisters applied in the locality of the growth, and the administration of colchicum internally.

Iodide of potassium and sarsaparilla were then given, and the swellings completely disappeared, but they returned while the medicine was still being taken. Mercury and opium were then given, and the growth again disappeared, but the man's health broke down, and the medicine was discontinued. Upon a re-

[1] Holmes's *System of Surgery*, 2nd ed. vol. iii. p. 822.

appearance of the ossification, dilute phosphoric acid in half-drachm, and subsequently in drachm doses, three times daily, was administered. 'The swellings greatly diminished under this treatment, and, with the repeated application of blisters, their recurrence seems to have been arrested.'[1]

[1] Holmes's *System of Surgery*, 2nd ed. vol. iii.

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